Appendix I

Local & Statewide Economic Impact Analyses

INTRODUCTION

The success or failure in eradicating pike from Lake Davis can reasonably be expected to have both local and statewide economic impacts. The analyses of local and statewide impacts require different assumptions, methodologies, and data, and for this reason two distinct analyses have been conducted and incorporated into this EIR/EIS as Appendix I.

The first, an analysis of local economic impacts, has been conducted by the Center for Economic Development at Chico State University (CSUC). That study, Attachment 1, was begun in the summer of 2005, and a preliminary report was completed in March of 2006. CSUC will be completing additional survey work for the project in the summer of 2006, and a final report is to be completed in the fall of 2006. Most of the material from the CSUC study is incorporated into Section 12, "Economic Resources," of the EIR/EIS, which focuses on the local economic impacts of the project alternatives. This includes many underlying assumptions from the CSUC study, as well as the fundamental economic relationships between recreation use and local economic activity, including effects on economic output, income, and employment. However, the analysis presented in Section 12 differs in several respects because of the distinct times at which the two studies were undertaken and the resultant differences in key assumptions underlying the analyses. As noted, the CSUC study commenced in the summer of 2005, while the economic analysis prepared for the EIR/EIS did not begin until early 2006. Based on the refinement of project alternatives and additional research and coordination with public agencies maintaining jurisdiction in the project area over the intervening six month period, the main differences between the CSUC study and Section 12 are the number and description of project alternatives and projected recreation use levels under these alternatives. The alternatives defined more recently were based on the duration and extent of drawdown and refill of Lake Davis and associated impacts on fishing, boating, and other recreational activities in the area.

The second study, Attachment 2, is an analysis of statewide economic impacts under the assumption that pike would escape from Lake Davis and become established downstream through and possibly beyond the Sacramento-San Joaquin Delta. This scenario relates to the analysis of the No Project/No Action alternative that is included in the EIR/EIS. The two economic studies conducted for this project incorporate different sets of assumptions, methods, and data.

This introduction to Appendix I presents an overview of the two economic studies, including their similarities and differences. There are two sections in this overview. The first reviews the purpose, assumptions, analytical approach, and results for the local economic study. The second includes the same topics for the statewide analysis.

LOCAL ECONOMIC STUDY

Purpose

The stated purpose of the CSUC study is to examine the short- and long-term economic effects of treatment and No Project alternatives at both the local and state levels. The three key elements of the CSUC study include:

1. Estimate the economic impacts of pike eradication on the Plumas County economy;

2. Estimate the value of Lake Davis to all recreationists, including those from outside Plumas County; and

3. Estimate the statewide impacts and costs should the pike escape Lake Davis and become established in California rivers and streams.

Assumptions

Critical assumptions included in the study relate to the amount of time for which Lake Davis would be unavailable to recreationists and to whether eradication is successful or not. The timing assumptions used by CSUC were those available at the time they began work on the project. The assumptions developed since then and ultimately incorporated into the EIR/EIS differ.

Other related critical assumptions relate to the time required for restoration of the trout fishery in Lake Davis following treatment. With successful eradication, CSUC assumes that the catch rate for trout would double in the following four years and would induce a 63 percent increase in angling at Lake Davis. If eradication is not successful, the study also assumes that the catch rate would double in the following four years due to short-term reductions in the number of pike in Lake Davis, but then decline to current levels in the subsequent six years due to the return of pike to pre-treatment levels.

Approach

The general approach used by CSUC includes the following steps:

1. Estimate recreational spending per visitor day (VDY) for various types of goods and services (from CSUS surveys at Lake Davis boat ramps);

2. Estimate total numbers of VDY from CSUS surveys, DFG angler surveys, and USFS campground usage data;

3. Estimate total spending by recreationists by affected business sector, for example restaurants, motels and hotels, service stations, and sporting goods stores;

4. Use an "Input-Output" (I-O) model to translate the spending impacts to estimate the effects of Lake Davis recreational use on the Plumas County economy;[1]

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[1] An I-O model measures the linkages among industries in an economy. The approach is summarized in Appendix I-2.

5. Analyze the impacts of different alternatives;

6. Combine information from the preceding steps with the impacts of DFG eradication activities and expenditures to calculate the net economic impacts on the Plumas County economy.

CSUC staff surveyed recreationists at the Lake Davis boat ramps for 13 days between the middle of September and the middle of October in 2005. During that time, the staff interviewed 195 parties which included a total of 384 visitors. On the basis of the survey, CSUC estimates that 97.5 percent of visitors are from outside Plumas County and that the average duration of stay at Lake Davis is 2.66 days.

CSUC developed estimates of economic impacts for four alternatives concerning Lake Davis:

1. Drawdown to 10,000 – 20,000 acre-feet from January through September of the project year, then treatment followed by trout restocking the following May.

2. Dewatering, resulting in the inability to use boat ramps at the lake from March in the project year through April four years later.

3. Drawdown to 48,000 acre-feet, with treatment in the summer and fall of the project year. Boat ramps would be usable until then. Trout restocking would begin in the late spring of the following year.

4. No Project and no change in the availability of Lake Davis for recreationists. Trout stocking would continue as would current pike management programs.

Results

Spending Patterns and Visitation by Recreationists

Based on the surveys taken in September and October of 2005, CSUC estimated that total visitor spending by Lake Davis recreationists was $26,500 (rounded), or $35.60 per VDY. The spending included $8 each for restaurants and lodging, $9 for transportation, $5 for groceries and beverages, and $3 for other local retail goods and services.

Impacts on Plumas County

CSUC estimated the impacts of the various treatment and No Project alternatives using the I-O model described previously. The results are shown in Table I-1. Results are presented for a 22-year period corresponding to the elapsed time for two complete eradication cycles, assuming the first fails. The table shows, for example, that under the Preferred Alternative, if successful, recreation at Lake Davis would support $20.42 million in output over 22 years, a net present value of $14.2 million.

As shown, all of the treatment alternatives analyzed in the CSUC paper are preferable to a continuation of current pike management programs at Lake Davis (corresponding to the No Project/No Action alternative). Assuming either successful or unsuccessful eradication of the pike, the treatment alternative involving drawdown to 48,000 acre-feet would provide the

greatest economic impact for Plumas County. Maintaining the current pike management regime would provide the least economic impact. As noted in the CSUC study, the impacts among the treatment alternatives are relatively small.

Table I-1. Comparison of Impacts of Alternatives on the Plumas County Economy

Alternative and Treatment Outcome	Impact on Plumas County Income (Millions of $2005)	
	22 Years	Net Present Value[1]
Preferred		
Success[2]	$20.42	$14.2
Failure[3]	$15.75/$13.32	$11.12/$9.75
Dewatering		
Success[2]	$18.56	$12.52
Failure[3]	$15.13/$13.43	$10.20/$9.39
48,000 Acre-Feet Drawdown		
Success[2]	$20.70	$14.47
Failure[3]	$16.34/$13.60	$11.60/$10.02
No Action	$10.35	$7.57

1. Net present value for 22 years, discounted at 3 percent per year

2. Pike is eradicated with one treatment

3. Pike is not eradicated, and treatment is either: 1) repeated in 11 years; or 2) not repeated

STATEWIDE ECONOMIC ANALYSIS

Purpose

The purpose of the statewide economic analysis is to assess the economic impacts in California of pike escapement from Lake Davis, which could occur if the proposed treatment of the lake is not implemented (i.e., No Project/No Action alternative). The two primary areas of focus are: (1) the potential economic impacts generated by physical effects on recreational and commercial fisheries in and beyond the San Francisco Bay/Sacramento-San Joaquin Delta (Delta); and (2) agricultural economic impacts from a potential regulatory reduction in Delta water exports. Regulators may reduce such exports to prevent movement of the pike through the pumps for the State Water Project (SWP) and Central Valley Project (CVP) and to minimize physical impacts on threatened and endangered fish species.

The statewide study does not evaluate the risk or probability of either pike escapement or that someone may plant pike illegally in Lake Davis or any other body of water. Instead, it incorporates hypothetical inputs on the possible physical impacts of pike escaping Lake Davis. The specific impacts on Delta smelt, salmon, or other species in the Delta from pike escapement have not been quantified in the EIR/EIS because of the highly-speculative nature of any such assumptions. Thus, the statewide analysis should be viewed as an example of the analytical approach which could be used and the results which could occur under the stated uncertain assumptions.

Assumptions

The most important assumptions underlying the analysis relate to the likely impacts of pike escapement on counts of recreational/commercial fisheries and protected species (e.g., Delta smelt) from Grizzly Creek Dam through and beyond the Delta. The adverse impacts on recreational fishing, both freshwater and marine, are assumed to be partially offset by anglers' use of other recreational fishing areas. The substitutability of one angler location for another depends on many factors such as the aesthetic characteristics and amenities of alternative sites Because data are not available to permit the extent of such substitutability, a hypothetical reduction of 10 percent in Delta angler visitor days is used. It is also assumed that half of these displaced anglers would fish at other recreational venues and that the resultant net impact would be a reduction of five percent in Delta angler visits.

For commercial fishing, it is hypothesized that the quantity of fish landings would decline by 10 percent. Only those species that would serve as prey to the pike were considered, primarily salmon off the central and northern California coast, and to a lesser extent some commercial fisheries in the Delta. It is further assumed that there would be no substitution for lost commercial angling opportunities (e.g., shift to fishing for other species or other parts of the State), and as a result, reductions in commercial angling would be a complete economic loss to the state.

The impacts on Delta water exports of pike escapement are uncertain. It is possible that exports would be curtailed by government agencies in an attempt to prevent the spread of pike south of the Delta, but the percentage reduction and duration of time are unknown. For this analysis, a hypothetical 10 percent decline in SWP and CVP exports is assumed, to demonstrate the important relationship between water deliveries and economic activity. Because of the SWP shortage policy, the reduction in exports by that agency would be shared by agricultural and municipal and industrial (M&I) contractors in proportion to their respective SWP contracts. Because of the CVP shortage policy and the magnitude of the hypothetical reduction, the reduction in exports by that agency would impact only agricultural contractors.

Approach

The general approach used for the statewide analysis includes the following steps:

1. For recreational fishing:

   a. Calculate the physical impacts of a 10 percent reduction in reported numbers of fresh water and salt water anglers and angling days for California residents and non-residents.

   b. Reduce the negative impacts on California residents by one half to reflect the assumption that 50 percent of anglers displaced from areas downstream of Lake Davis would fish in other California locations. Account for the impacts to non-residents as a complete loss because of their assumed travel to other states for angling.

   c. For fresh water anglers, multiply the estimated reductions by the components of the visitor spending profile developed in the CSUC study to determine the expected effects on the key affected business sectors such as transportation, lodging, and restaurants.

   d. For salt water anglers, multiply the estimated reductions by the components of the spending profile developed by NOAA Fisheries to determine the expected effects on the key affected business sectors such as transportation, lodging, and restaurants.

2. For commercial fishing:

   a. Quantify the total commercial catch and value of fish landings off the California coast and in the Delta that would be potentially affected by pike escapement, namely to salmon and salmon roe off the coast and threadfish shad, Pacific lamprey, and crayfish in the Delta.

   b. Calculate a 10 percent reduction factor in commercial fish landings and value based on the landings estimated in (a).

3. For agricultural production:

   a. Tabulate average cropping patterns and crop farm gate value for Fresno, Tulare, Kings, and Kern Counties, the principal counties receiving Delta water for agricultural use.

   b. Calculate average farm gate value per acre of harvested cropland.

   c. Estimate the amount of cropland which would be fallowed because of reduced agricultural water deliveries, assuming average consumptive use of 2.5 acre-feet of water per acre per year for the representative crop mix.

   d. Calculate the value of lost production by allocating the acreage declines across individual crops in proportion to their individual acreages.

4. For regional economic impacts

   a. Input the direct impacts on various industries from the hypothetical scenarios for recreational and commercial fishing and agricultural water supplies.

   b. Use the I-O model described previously to estimate the indirect, induced, and total economic impacts in California based on the direct impacts of pike escapement from Lake Davis.

The analysis of impacts on M&I water supplies from a 10 percent reduction in Delta exports is qualitative in the statewide study because of very limited data. SWP exports of M&I water would be reduced by that amount, while CVP exports of M&I water would be unaffected. The impacts on each SWP M&I contractor would differ depending on such factors as the timing of the reduction, availability and cost of alternative water sources, feasibility of continued use of those sources, and the potential for conservation savings. If alternative supplies are available, it is reasonable to assume that their costs will be greater than for SWP water and that contractors would pass on those costs to users, analogous to a tax increase.

Industrial impacts would also differ for each SWP contractor. In the long term, it may be necessary for some businesses to seek supplemental supplies, likely at higher costs. If the incremental costs are so great as to significantly reduce profitability of the businesses, some may choose to leave the area. However, absent specific data on how many businesses in each industry would be affected, the intensity of their water use, and many other key variables, those impacts cannot be quantified.

Results

The results from using the hypothetical scenarios and inputs are presented below. Because the analysis relates specifically to pike escapement, these results would apply only to the No Project/No Action alternative considered in the EIR/EIS.

Recreational Fishing

A hypothetical change of 10 percent in freshwater fishing participation potentially affected would lead to direct estimated statewide annual declines of $10.0 million in output and $3.5 million in labor income, concurrent with the loss of 116 jobs. Total impacts would include annual declines of $17.8 million in output and $6.1 million in income as well as the loss of 175 jobs. Total impacts include those in the directly-affected businesses as well as the many other sectors which support and are supported by those businesses.

The impacts from saltwater fishing are smaller because of fewer anglers. Losses would include direct annual declines of $0.86 million in output, $0.3 million in income, and 9 jobs. Total economic impacts would include annual declines of $1.49 million in output and $0.51 million in income as well as 14 jobs.

Commercial Fishing

The assumed 10 percent reduction in commercial fishing catch would lead to direct annual losses of $1.81 million in output and $1.01 in income as well as 46 jobs. Total economic impacts would include annual losses of $3.47 million in output, $1.6 million in income, and 59 jobs.

Agricultural Production

Based on the hypothetical 10 percent reductions in SWP and CVP Delta exports, annual agricultural output in the San Joaquin Valley would fall by $332.6 million and labor income would decline by $98.9 million. Approximately 3,240 agricultural jobs would be lost. The total economic impacts would include annual losses of $534.8 million in output, $179.18 million in income, and a decline of 5,445 jobs.

Total Regional Economic Impacts

The estimated total statewide economic impacts from pike escapement are summarized in Table I-2. Total direct output would decline by $345.3 million annually and income would fall by $103.7 million annually. Approximately 3,411 jobs would be lost in the recreational

fishing, commercial fishing, and agricultural production sectors. Total output losses would be $557.5 million and total income losses would be $187.4 million, both on an annual basis. Job losses would be 5,693. The largest declines would be in agricultural production because of reduced water supplies and the assumption that other water supplies would either not be available or would be very expensive.

The estimated total regional economic impacts of pike escapement, based on the assumptions outlined above, would be substantial. However, compared to the total value of economic output in California ($2.48 trillion in 2003), these impacts would account for less than 0.01 percent of statewide output. The impacts on San Joaquin Valley agriculture would be comparatively much greater. Relative to farmgate value of $7.29 billion (2004 dollars) in Fresno, Kern, Kings, and Tulare Counties, the decline in direct agricultural output would be about 4.6 percent.

Table I-2. Estimated Economic Impacts of Pike Escapement on the State Economy

Measure	Direct Impacts	Total Impacts
Recreational Fishing (Freshwater)		
Output ($million)	-$10.00	-$17.75
Income ($ million)	-$3.47	-$6.12
Employment (jobs)	-116	-175
Recreational Fishing (Marine)		
Output ($million)	-$0.86	-$1.49
Income ($ million)	-$0.30	-$0.51
Employment (jobs)	-9	-14
Commercial Fishing		
Output ($million)	-$1.81	-$3.47
Income ($ million)	-$1.01	-$1.60
Employment (jobs)	-46	-59
Agricultural Production		
Output ($million)	-$332.62	-$534.8
Income ($ million)	-$98.89	-$179.18
Employment (jobs)	-3,240	-5,445
Total		
Output ($million)	-$345.28	-$557.52
Income ($ million)	-$103.67	-$187.41
Employment (jobs)	-3,411	-5,693

1. All dollar values are in 2005 terms.

REFERENCES

California Department of Finance. 2005. "California Statistical Abstract 2004," Internet website http://www.dof.ca.gov/html/fs_data/STAT-ABS/sec_D.htm, accessed June 26, 2006.

California Department of Fish and Game. 2006. "Lake Davis Northern Pike Eradication Project EIR/EIS Statewide Economic Analysis." ENTRIX, Inc., Sacramento, California.

California Department of Water Resources. 2006. "California Water Plan Update 2005." Sacramento, California.

Center for Economic Development, California State University at Chico. 2006. "The Economic Impact on Plumas County of Alternative Northern Pike Eradication and Management Scenarios for Lake Davis: A Preliminary Report." Chico, California.

Appendix I, Attachment 1

Analysis of Local Economic Impacts

THE ECONOMIC IMPACT ON PLUMAS COUNTY OF ALTERNATIVE NORTHERN PIKE ERADICATION AND MANAGEMENT SCENARIOS FOR LAKE DAVIS: FINAL REPORT

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Executive Summary

Ranking the alternative methods of dealing with the northern pike problem in Lake Davis is relatively straightforward when the sole criterion is the economic impact on the Plumas County economy. The analysis contained in this report supports the conclusion that eradication is preferable to the current management program. Compared to the use of the current pike management program alone, even a failed attempt at eradication yields a better economic outcome for Plumas County. Among the alternative methods of eradication proposed scenario 3 yields the greatest local economic benefits, although scenario 1, the preferred alternative, is a close second. Both are preferable, on the basis of economic impact, to scenario 2 since the latter implies the loss of the recreational use of the lake for a full three years.

For each of the scenarios Plumas County income was estimated for a 22 year period or two eradication cycles. For the three eradication scenarios (scenarios 1-3) the total income impacts for successful eradication are $17.82 million, $16.19 million, and $18.06 million (in undiscounted constant 2005 dollars) respectively. The multiple failed eradication case (one of two failed eradication cases considered, the other being just a single attempt) leads to 22 year income impacts of $14.26 million for scenario 3, $13.74 million for scenario 1 (the preferred alternative), and $11.59 million for scenario 2. For all eradication scenarios, estimated income impacts, even where eradication efforts fail, exceed the contribution Lake Davis will make to Plumas County income with a continuation of the current pike management program alone (scenario 4). It is estimated that continued pike management without an attempt to eradicate the pike will generate only $9.03 million in local income over the next 22 years.

The choice between scenarios 1 and 3 is a difficult one and one that cannot be made on the basis of economic impact alone. For the successful eradication case there is a difference of just $18,840 in the annual effect on gross sales and a difference of $11,041 in the estimated impact on annual local income. While the differences are greater for the failed eradication case, the disparity is insignificant relative to the gap between the successful and failed eradication cases. If eradication were to be unsuccessful, and were to be repeated periodically (every 11 years in this case), under scenario 3 annual gross business sales would average $295,166 less (over the 22 year period used in the analysis) than for the successful case. In addition, annual income would be lower by an average of $172,972. The disparity between impacts on gross business sales and local income are likewise significant for scenario 1, the preferred alternative. Under this option a failed eradication effort with multiple attempts would reduce average annual gross sales and local income by $316,254 and $185,330, respectively.

On the basis of economic impact on the Plumas County economy, a pike eradication effort by any of the proposed methods is preferable to continuing the current pike management program alone. And, since the differences in the impacts among the alternative scenarios are insignificant (at least for scenarios 1 and 3) relative to the local economic cost of a failed eradication attempt, the particular eradication method chosen should be the one having the greatest probability of success.

Introduction

Purpose of the Study

The purpose of this economic study is to examine the short- and long-term economic effects of pike and pike eradication efforts both locally and statewide. There are two key elements to the economic analysis that need to be completed in order to accomplish this purpose. The first is to estimate the economic impacts of pike eradication efforts on the Plumas County economy. Second, a travel cost study is undertaken to estimate the value of Lake Davis to all recreational users including those from outside of the county.

The study examines the economic costs and benefits of several pike eradication scenarios. It will function as an informational document for the California Department of Fish and Game (DFG) and the general public in regards to the relative economic effects of various methods to eradicate pike including the no project alternative. This economic study is being conducted separate from, but in parallel with, a joint Environmental Impact Report/Environmental Impact Statement being prepared by a private consultant under contract with the DFG.

Cautionary Notes

Study Scope

The impacts assessed in this study are limited to those non-resident users of the recreational resource directly affected by the quality of the lake and fishery. Thus the analysis focuses on non-resident anglers and boaters and thus the number of annual visitors used in the analysis is considerably smaller than what is used In the EIR/EIS.

Impacts on Local Property Values

The analysis contained within this report estimates four local economic impacts associated with pike eradication efforts at Lake Davis: gross sales, income, employment, and county government revenues. There is another possible impact that is not included and that is the potential transitory impact on local property values that might be experienced during the treatment process. There are two reasons for excluding this potential impact, the most important of which is that it is impossible to determine with any degree of precision. The excluded effect is that local recreational property might become less attractive to buyers from outside of the county. This could occur for two reasons: because the lake level has been lowered during the treatment process and thus is unavailable for a period of time that depends on the scenario chosen, or because of the adverse publicity associated with the real or imagined consequences of the treatment itself. The impact of the lake closure should, at most, be the interest cost of delaying property sales for the period of time the lake is closed and is not likely to be significant relative to the estimated impacts on local income contained in the report.

Second, the effect on property values generated by changes in local income is already included in the local economic impact estimates. Income impact estimates include the effect on property income and thus including a property value impact would involve double counting.

Some might point to the effects on property values experienced during the 1998 treatment as evidence that this impact is large and should not be excluded from the analysis contained within this report. However, examination of that evidence is likely to lead to the conclusion that the effects of closure of Lake Davis during those years cannot be separated from the other factors that affected property values in the mid to late 1990's. Rising interest rates and other national and state economic factors depressed real estate prices throughout California and recovery of real estate prices did not begin in earnest until interest rates declined after the year 2000.[1]

Economic Impact Analysis

The economic impact analysis performed for this study is used to estimate the effect on local economic activity of the various pike eradication scenarios. There are four key elements to this analysis. First, the amount of spending per visitor day is established for several important industry specific categories. This information is derived from the surveys administered at various Lake Davis boat ramps by employees of the Center for Economic Development (CED) at the California State University, Chico. Second, the total number of annual non-resident visitor days is estimated. This is accomplished using the CED surveys and counts, the DFG angler surveys, and campground usage data obtained from the U.S. Forest service. Spending per visitor day by industry sector is multiplied by the estimated total of visitor days to determine total spending by industry category. The third element of the analysis is to use the industry spending data in conjunction with the IMPLAN input-output model to calculate the annual impacts of Lake Davis recreational use on Plumas County output, income, employment, and county revenues. Fourth, adjusting for effects of fishery quality on lake usage and the amount of time the lake would be unavailable under the various pike eradication scenarios, allows computation of the relative economic impacts of the four scenarios analyzed.

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[1] Plumas County did experience a decrease in new homes permitted (one measure of property related activity) in 1999. The decrease was from 123 in 1998 to 101 in 1999, or less than an 18% decrease. By the year 2000 housing permits had increased to 188, with increases to 191 and 260 in the next two years. By way of comparison, Lassen County experienced a decrease in new homes permitted of 31% from the 1996 peak to the activity level in 1997 and 1998, with recovery to the 1996 level delayed until 2002. Adjacent Yuba County saw a surge in building activity in 1999 (probably due in part to damage from the 1997 flood), a 62% decline in new housing permits issued in 2000, and rapid growth in building activity beginning in 2002. Sierra County experienced a decrease in new housing permits issued of almost 41% for 1997 and 1998 from the year 1996 with a return to 1996 levels in the year 2000. In general, while the timing is not precisely the same, surrounding counties experienced larger percentage downturns in late 1990's housing construction activity than did Plumas County. (DOT 2005)

While the majority of the economic impacts are likely to be felt in the City of Portola, the analysis is performed for Plumas County as a whole. It would be possible to separate the impacts for Portola from those of the remainder of the county by running the IMPLAN model at the ZIP code level. However, the authors' previous experience with IMPLAN is that the smaller the defined economic unit, the less reliable the estimates.

The local economic impacts contained in this report can be interpreted as worst case estimates. First, this is true if the county-wide impacts are assumed to represent the effect on the Portola economy. Second, there is the implicit assumption that all of those non-resident recreational users of Lake Davis will find other options outside of Plumas County. That, in fact, may not be the case and therefore a portion of the estimated visitor spending may still positively affect the local economy.[2]

Resource Valuation

Estimation of the value of the Lake Davis is accomplished using a travel cost model. The use of travel cost to estimate the demand for recreational sites was first suggested by H. Hotelling in the late 1940's. The model was further developed by Knetsch and Clawson in the 1950's and 1960's and has since gained broad acceptance among resource economists. The literature in resource and environmental economics contains numerous studies using variations on the travel cost model.

This approach to valuing a resource is based on the idea that the cost of getting to a recreational site is a measure of the value individuals place on its use. A demand curve is generated from the various travel costs and the associated number of trips. It is fundamental to economic theory that the higher the price of a good or service the smaller the quantity demanded. In the vernacular of the travel cost model this means that as travel cost increases, as it does with distance from the site, the smaller the number of trips made annually. The total value of the resource is estimated as the area under the generated demand curve but above the average travel cost for all surveyed users. In order to maintain the continuity of the economic impact analysis, the results of the travel cost study are included in Appendix A instead of the main body of the report.

Background

Plumas County

Plumas County is located in Northern California, bordered by Lassen County on the north and Sierra and Yuba counties on the south. In 2004 Plumas County had a population of 21,230 and total wage and salary employment of 7,630. The average salary per worker was $35,840. With total county personal income of $632.23 million, 2004 per capita income was $29,780, and median household income was estimated at $53,900.

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[2] Sixty percent of those responding to the survey indicated that they would "definitely" or "probably" come to the area even if Lake Davis were unavailable.

Wage and salary employment grew by 50 jobs during 2004, representing a slowdown from the rate of job growth experienced in the four previous years. Most of the jobs created during 2004 were in leisure services, retail trade, construction, and agriculture, with retail trade adding 80 jobs during the year. Employment in some other sectors actually declined, with the largest decrease in the government sector which lost 81 jobs. Annual employment growth is expected to increase to 150 new jobs in 2005, and then to stabilize at between 50 and 100 new jobs annually through the year 2025.

In 2004 the Plumas county population increased by 0.6%, while the population of the incorporated city of Portola declined by 0.5%. The county's rate of population growth through the year 2025 is forecast to remain below the state average and is expected to increase at 0.6% annually for the 2005-10 period and remain well below 1% annually through 2025.

Real per capita income is forecast to increase by 1.8% in 2005, slowing to a 0.8% rate of increase over the next five years. Taxable sales are also expected to grow in 2005 at a rate above the long term trend, or by 4%, slowing to an average of 2.1% annually over the next five years. In nominal terms (unadjusted for inflation) the rate of growth in taxable sales is forecast to grow at a 4.02% annual rate through the year 2025. Through the year 2025 nominal personal income is forecast to grow at a 2.95% annual rate, with an annual real rate of growth averaging less than 0.5%. (DOT 2005)

Northern Pike in Lake Davis

Lake Davis is located in the Feather River drainage of the Sacramento River system at an elevation of 5,775 feet. The dam creating the lake was constructed by the California Department of Water Resources (DWR) in 1967. It is located near Portola in Plumas County on Big Grizzly Creek, a tributary to the middle fork of the Feather River. It has a storage capacity of 84,371 acre feet, covers 4,026 acres, and has a mean depth of 20.5 feet. (Lee 2001)

The existence of northern pike in Lake Davis was initially confirmed by an angler catch in August of 1994. Northern pike were caught with increasing frequency through 1994 and 1995 and in 1995 the DFG "…concluded that the eradication of the predatory pike was necessary in order to prevent their further spread in the state and to protect the trout fishery in Lake Davis". (Lee 2001, DFG 2003)

1997 Pike Eradication Efforts

The DFG received the necessary permits by October 1997 and on October 14, 1997 treatment with powered rotenone and liquid Nusyn-Noxfish began. The lake still held 50,000 acre feet at the time of treatment, 20,000 acre feet more than it would have had the project not been delayed by a restraining order. By late November of that year it was determined that most of the treatment chemicals had degraded except for pipernyl butoxide. The persistence of this synergistic chemical was aided by a thick icecap and low water temperatures, and because of its presence, restocking with rainbow trout was

delayed until June of 1998. Unfortunately in May 1999 northern pike were again discovered in Lake Davis. (Lee 2001)

Pike Population Management

Following a May 1999 meeting between then DFG Director Robert Hight and members of local communities, a task force was formed to study pike management options and to develop recommendations.   Input concerning potential alternatives was sought from the public, and, fishery biologists and others having direct experience with pike population management were brought in to discuss and evaluate suggested control strategies. In January of 2000 the task force steering committee and DFG jointly authored a report entitled *Managing Northern Pike at Lake Davis: A Plan for Y2000* containing a series of recommended strategies for northern pike population control. (Lee 2001, SLDTFSC/DFG 2000)

Program Results

In September 2003 DFG published a report outlining the results of over three years of northern pike population management at Lake Davis. The report concluded that, although field crews removed 28,100 pike weighing 4,250 pounds, the yearly harvest continued to increase and pike density increased through at least the first three years of the program. There were two important adverse consequences resulting from the failure of the implemented management techniques to limit pike populations. First, due to increasing numbers of northern pike, the risk of release to downstream waterways has increased. Second, the catch rate for rainbow trout had declined substantially, falling from a rate of 0.28 per hour in 2000 to 0.12 per hour in 2003. (DFG 2003) The decline in trout fishing success in all likelihood imposed economic costs on the local economy with a 33% decrease in visitor days recorded at Lake Davis campgrounds between 2000 and 2004. (USFS 2005)

Scenarios Analyzed

Scenario 1: Preferred Alternative

Description

The preferred alternative involves drawing the lake down to a volume of between 10,000 and 20,000 acre feet and then applying a liquid rotenone formulation in order to eliminate the pike. The rotenone treatment would also extend to tributaries to the lake, wetlands, and other potentially infested areas within the Lake Davis watershed. Drawdown would take place between January and September of the project year, and depending on the rainfall year, would result in a volume of water within the lake of 10,000 to 20,000 acre feet by September of the same year. Neutralization of the rotenone will occur by one of a number of methods currently under evaluation. (DFG 2005)

Impacts on Fishery and Lake Availability

Lake Davis boat ramps will be unusable when the lake level drops below 40,000 acre feet. With the draining commencing in January of year 1 that level is likely to be reached by March of the same year. Following eradication, trout will be restocked in May of year 2 and at that time the lake will be available for the full spectrum of recreational uses. It is assumed that successful eradication of pike will lead to an improvement in the trout fishery of 100% by year 5.[3] If eradication efforts are unsuccessful it assumed that it will be a periodic effort (e.g. once every 11 years) or will be attempted just once and the trout fishery will improve by 100% by year 5 and decline to pre-treatment levels by year 11. If just one treatment is attempted the fishery quality will continue to decline after year 11 until the catch rate falls by an additional 50% by year 21.

Scenario 2: Complete Dewatering of the Reservoir

Description

This alternative involves the use of existing dam outlets and pumps and the use of additional piping and siphons. Installation of structures will be necessary in order to prevent downstream release of adult pike, juveniles, larvae, or eggs. In the summer or fall, and when lake volume reaches 90 acre feet, the remaining water and all inflow will be treated with rotenone. (DFG 2005)

Impacts on Fishery and Lake Availability

Under this alternative Lake Davis boat ramps will be unusable between March of year 1 and April of year 4. Following eradication, trout will be restocked in May of year 4. Successful eradication is assumed to lead to the same improvement in trout fishery quality described under the preferred alternative. As with the preferred option, the impact of this method will be evaluated under the alternative assumptions that eradication of pike is a successful one-time event, that it is unsuccessful and will be repeated periodically, or that it is attempted just once. The impact on catch is assumed to follow the same post treatment patterns used in the analysis of the preferred alternative.

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[3] In 2000 the catch rate for trout in Lake Davis was 0.28 trout per hour, but by 2003 that rate had declined to 0.12, presumably due to increased predation by northern pike. Thus removal of pike from the lake should result in a comparable reversal of the catch rate, leading to more than a 100% increase in the number of trout caught per hour. Even though an increase from 0.12 to 0.28 is more than a 100% increase, it is assumed that the quality of the fishery increases by just 100%. That is because quality (and angler response to quality changes) is also affected by the size of fish caught and the average size of trout caught has increased significantly over the same period. (DFG 2003, Loomis 2005)

Scenario 3: Draw Down to 48,000 Acre Feet

Description

For this alternative the minimum lake level will be 5,767 feet above sea level and the lake volume will not fall below 48,000 acre feet. The standing water and all flowing water will be treated with liquid rotenone in the summer or fall of year 1. Until treatment occurs boat ramps will remain usable. Restocking will be done in late spring of year 2. (DFG 2005)

Impacts on Fishery and Lake Availability

This option somewhat reduces the time the lake will be unavailable (boat ramps can remain open), however since trout will not be restocked during year 1 and the lower water level will reduce the aesthetic value of the lake for recreation, use during year 1 is likely to be reduced substantially.   Successful eradication is assumed to lead to the same improvement in trout fishery quality described under the preferred alternative. As with the preferred option, the impact of this method will be evaluated under the alternative assumptions that eradication of pike is a successful one-time event, that it is unsuccessful and will be repeated periodically, or that it is attempted just once. The impact on catch is assumed to follow the same post treatment patterns used in the analysis of the preferred alternative.

Scenario 4: No Action

Description

Under this option there will be no attempt to eradicate the pike from Lake Davis. The current management plan, implemented to control the numbers of pike in the lake, will be continued. This option might include continued stocking of trout, although it is likely that a change towards larger fish, less susceptible to predation by pike, will be desirable. (DFG 2005)

Impacts on Fishery and Lake Availability

If this option were chosen there would be no interruption in the availability of the lake for recreation. Under the continued stocking alternative the quality of the trout fishery it is assumed to decline with average trout populations declining 25% by year 5 and 50% by year 10. (DFG 2005)

Survey and Results

General

Surveys and visitor counts were conducted at Lake Davis on 13 days in September and October of 2005 and for 12 days during May, June, and July of 2006. Over that time interval 238 parties were surveyed representing 477 individual visitors. (See Appendix B for the actual form used). Interviews were conducted at four boat launch points including Honker Cove, Mallard Cove, Eagle Point, and Camp 5. Some refused to be surveyed, but the majority of those approached willingly participated.

There was an average of 2.01 individuals per interviewed party with 97.4% of those interviewed visiting from outside of Plumas County. The duration of the average visit was 3.14 days, while the average visiting party makes 2.09 trips to Lake Davis annually. Most visitors (87.5%) listed the primary purpose of their visit as fishing, with 5.73% visiting friends and the remainder traveling to the area for business or other recreation. 67.9% of surveyed visitors stayed in the local area, with 46.0% of those staying locally utilizing campground facilities, 18.0% staying in hotels or motels, 14.9% staying with friends, and the remainder listing "other", primarily second homes.

Visitor Spending

Local expenditures for all surveyed non-residents totaled $42,648, or $31.06 per non-resident visitor day.[4] The expenditures were entered into six separate categories for use in the local impact analysis. Local spending per visitor day was $7.06 for restaurant meals, $7.05 for lodging, $7.73 for transportation, $2.38 for fishing-related spending, $4.57 for groceries, and $2.27 for other local retail. [5]

Impact of Presence of Northern Pike

Of those surveyed 96.6% were aware of the presence of northern pike in Lake Davis. Most (85.7%) indicated that it did not affect their willingness to utilize the lake fishery. For the few individuals saying that it did affect the number of annual visits, six said the presence of northern pike in the lake increased the number of annual visits, while 16 said that knowledge reduced the number of annual visits. However, when considering the impact of pike predation on the trout catch rate, there is likely to be a substantial negative impact on annual use of the Lake Davis fishery.

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[4] Total spending per non-resident visitor day is somewhat lower than what was used in the Preliminary Report. The additional surveys done during the summer of 2006 reduced average daily spending from $35.60 to $31.06.

[5] Due to a misunderstanding with those conducting the surveys during the May through July, 2006 period spending was reported as a total instead of being separated by expenditure category. Therefore, the total spending is allocated to the individual expenditure categories based on the surveys done during September and October of 2005. Because the majority of the surveys were collected in the earlier period and since sector spending multipliers are very similar, this approach has no significant impact on the study results.

Effect of Catch Rate on Annual Visits

Only 26.05% of surveyed anglers reported that they typically caught their daily limit of trout at Lake Davis. When asked if they would increase their annual visits to the lake were they to catch twice as many fish daily, 78.21% answered yes, with an average increase in annual visitation of 122.39%. Adjusting for the percent currently catching their limit and those who indicate no impact on their annual visitation, the implication is that a doubling of the catch rate would lead to a 63.2% increase in annual visitor days.[6]

Methodology

Estimating Total Annual Visitor Days

Data Sources

In order to estimate the local economic impacts of Lake Davis recreational use it is necessary to determine the total annual visitor days for lake users from outside Plumas County. Since no actual count has been made, usage must be estimated from sampling. There are three sources of data that permit estimation of annual use. First, the U.S. Forest Service (USFS) maintains a count of individuals using their campground facilities at the lake. Second, the California Department of Fish and Game (DFG) has done angler surveys and the summary data includes a total count for the days surveyed. Third, surveys were administered and counts made during September and October of 2005 by employees of the Center for Economic Development (CED). The range of estimates annual visitor days derived from the three sets of data is 13,291 to 22,360. Table 1 summarizes the estimates and a brief description of how each estimate was obtained is included in the following three sections.

Table 1: Estimated Annual Recreational Visitor Days at Lake Davis

Primary Data Source	Description	Annual Visitor Days
USFS Campground Data	Campground use for the years 2001-2005	22,360
DFG Angler Surveys	Based on 2001 angler counts unadjusted	18,041
DFG Angler Surveys	Based on 2001 angler counts adjusted to 2005 using USFS relative campground use	13,291
DFG Angler Surveys	Based on the average of five years of count data collected between 1986 and 2004	16,344
CED Surveys	Based on the average hourly count of recreational users	20,458
CED Surveys	Based on the average hourly weekday and weekend day count of recreational users	17,697

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[6] Those who currently catch their daily limit were asked if a halving (a 50% decrease) in their daily catch rate would affect the number of annual visits to Lake Davis. For those answering the question, 46.0 % said that it would decrease their annual use of the lake, with an average reported decrease of 38.09%. However, the relatively small sample size (17) makes the estimates of questionable value and they are not used in this report.

U.S. Forest Service Campground Usage Data

Campground usage data was obtained from the USFS for the years 1996 through 2005. The annual average for the ten year period was 28,807 campers with peak use in 2001, followed by a steady decline, falling to 20,653 campers by 2004. There was a slight increase in 2005 to a total of 21,569 campers. The annual use of Lake Davis in 2005 is obtained by taking the number of campers in that year and adjusting for the number who would come even if the lake were unavailable for use.

In May and June of 1998, prior to the restocking that followed chemical treatment, the total campers at the USFS Lake Davis campgrounds totaled 584, or 6.7% of the 8715 camper 1999-2005 May-June average. Assuming that the difference represents recreational users of the lake, that would imply that 20,124 of the campers are there only because of the availability of the lake. Adjusting for the percent of lake users who camp implies that total annual use by non-residents is 22,360 visitor days.

California Department of Water Resources Creel Surveys

DWR surveys were administered for a number of years, involving twenty-eight days of surveying and angler counts between late April and early November. The 2001 survey is used here for purposes of estimating total annual angler use. In that year angler counts were obtained on twenty-eight days between April 28 and November 15. A total of 542 anglers were counted, or an average of 2.647 per hour. Adjusting for the 2562 fishing hours available annually (14 hours per day for 183 days) that leads to an estimated 2001 angler use of 18,041 visitor days. Adjusting for the difference in campground use between 2001 and 2005, results in an estimated 13,291 visitor days for 2005. If the average for the five years for which the DWR completed counts is used (excluding 1998), annual visitor days are projected to be 16,344. However, since the DWR counts include anglers only, both of these figures probably underestimate total annual visitor days by at least 12.5% (87.5% are primarily visiting to fish).

Current Survey Data Collected for This Study

Survey data collected by CED employees is used to obtain two separate estimates of annual visitor days at Lake Davis. First the average number of recreational users counted per hour of surveying, 2.363, is used to estimate use for September of 2005. The estimate of 2,347 visitor days is then divided by the ratio of total campers in September to the annual total, or 12.91% for 2005. Using this approach the estimated annual non resident usage of Lake Davis for the year 2005 is 20,458 visitor days.

A second method, using separate visitor counts for weekdays and weekend days, yields a lower estimate. Hourly counts for weekend days (3.07) and for weekdays (2.45) are multiplied by the available annual weekend and weekday fishing hours (for May 15-November 15), respectively. Annual non-resident visitor days at Lake Davis for 2005 are estimated to be 17,697 using this approach.

Visitor Spending by Category

Each surveyed visitor was asked to estimate his or her local spending delineated by six expenditure categories: restaurant meals, lodging, transportation, fishing related, groceries, and other local retail. The results are included in Table 2, summarized by total reported spending and spending per visitor day.

Table 2: Local Visitor Spending by Non-Residents: Total and Expenditures Per Visitor Day

Expenditure Category	Survey Total	Per Visitor Day
Restaurant Meals	$9,692	$7.06
Lodging	$9,680	$7.05
Transportation	$10,614	$7.73
Fishing Related	$3,270	$2.38
Groceries	$6,277	$4.57
Other Local Retail	$3,115	$2.27
Total Local Spending	$42,648	$31.06

The IMPLAN Input-Output Model

In order to determine the total impact on county income and employment, direct visitor expenditures are entered into the appropriate sector of the IMPLAN model for the Plumas County economy. IMPLAN is an input-output model (I-O) that separates the economy into 509 industrial sectors, classifying each according to the primary product or service it provides. The transaction matrix is the model that estimates impacts. The transaction matrix contains the purchases and sales that occur among the various sectors. The column entries are the purchases made by a particular sector from all other sectors included in the model. The row elements are the industry destinations of the sector's sales. The I-O model permits assessment of the total impact of an initial change in income or expenditures. (MIG 2005)

The total impact is the sum of the direct, indirect, and induced impacts. The indirect impacts are the result of purchases (by the sectors directly affected) from local industries supplying inputs. The induced effects are due to the spending of additional income earned through the enhanced business activity generated by the direct impacts. The model output includes estimated impacts on output, income, employment and state and local taxes.

Estimated Local Impacts per 10,000 Visitor Days

Output, Income, Employment, and Revenue Impacts

Table 3 contains the IMPLAN model estimates of the local economic impacts for each 10,000 non-resident visitor days at Lake Davis. The estimates are generated from the direct spending by sector listed in Table 2. The effect on total output, or $414,519, is

equivalent to total expenditures or gross business sales within Plumas County. However, since the value of output includes the value of inputs purchased from outside of the ounty, the output effect significantly overstates the impact on incomes within the county.[7]

The second row of Table 3 includes the direct, indirect, induced, and total income impacts. Income is defined as the sum of employee compensation, proprietor income, other property income, and indirect business taxes. The direct income effect is the result of visitor spending within the sectors designated in Table 2, while the indirect income impact is derived from purchases of inputs from suppliers within the county. The induced impact is the result of spending of the added income in the industries directly and indirectly affected by the visitor spending linked to the use of Lake Davis. The total income impact is simply the sum of the direct, indirect, and induced impacts, or $242,915 per 10,000 non-resident visitor days.

The employment impacts are included in the last row of Table 3. Visitor spending by non-resident recreational users of Lake Davis generates 9.4 jobs per 10,000 visitor days. However, these are not full-time jobs, but rather they are based on the Department of Commerce definition of employment. Employee compensation per job averages $12,945, far below the average full-time wage rate ($35,840 in 2004) within the county.

Indirect business taxes are included in the income impact and total $35,739 per 10,000 visitor days. Total state and local taxes, including income taxes and contributions to social insurance, are $40,879, with sales taxes ($16,858) and property taxes ($11,412) providing the bulk of the revenues. The local share of revenues is estimated to be $15,262 per 10,000 visitor days.

Table 3: Impacts on Plumas County Output, Income, and Employment per 10,000 Non-Resident Visitor Days

Impact Type	Direct	Indirect	Induced	Total
Output	$310,600	$49,809	$54,109	$414,519
Income	$181,595	$27,663	$33,656	$242,915
Employee Compensation	$95,498	$12,862	$13,618	$121,978
Proprietor Income	$38,438	$3,078	$3,038	$44,554
Other Property Income	$18,534	$9,185	$12,926	$40,645
Indirect Business Taxes	$29,126	$2,539	$4,074	$35,739
Employment	7.9	0.7	0.8	9.4

Individual Industry Impacts

Table 4 contains the IMPLAN estimates of total income impacts by sector for the Plumas County economy. The table includes all sectors where income is affected by more than

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[7] Output can be interpreted as gross business sales and that term is used in place of output in the summary tables at the end of the report. Since the impact of greatest concern for local businesses and employees is income, the majority of the analysis is focused on the effect on local income.

$5,000 per 10,000 visitor days ($0.50 per visitor day), and, the listed sectors receive 77% of the total income impact within the local economy. The greatest income impacts are in those sectors receiving the most direct visitor spending. Owners and employees in hotels and motels ($50,645); gasoline stations ($48,132); food services and drinking places ($34,794); and food and beverage stores ($27,918) receive the greatest boost to income from visitor spending linked to Lake Davis recreational use.

Table 4: Total Income Impacts by Sector per 10,000 Non-Resident Visitor Days

IMPLAN Sector Number	Sector Description	Total Income Impact
405	Food and Beverage Stores	$27,918
407	Gasoline Stations	$48,132
409	Sporting Goods	$11,045
431	Real Estate	$7,194
479	Hotels and Motels	$50,645
481	Food Services and Drinking Places	$34,794
509	Owner Occupied Dwellings	$8,379

Estimated Impacts for 2005

Income Impacts

The 2005 impact on the Plumas County economy of spending by recreational users of Lake Davis is calculated by multiplying the impacts per visitor day by the estimated visitor days for that year. Table 1 contains the various estimates for 2005 non-resident visitor days, and while the range is fairly wide (13,291 to 22,360), most of the estimates fall between 18,000 and 22,000 visitor days. Thus, the estimates contained here are based on a mid-range non-resident visitor day estimate of 20,000 with a variance of plus or minus 2,000.

Table 5 contains the estimated impacts of 2005 Lake Davis non-resident visitor spending on income of owners and employees of Plumas County businesses. The estimates include employee compensation, proprietor income, property income, and indirect business taxes. The income impact for the baseline estimate of 20,000 annual visitor days is $485,831, with a possible income impact ranging from a low of $437,238 (18,000 visitor days) to a high of $534,414 (22,000 visitor days).

Table 5: Estimated 2005 Income Impacts on the Plumas County Economy

Impact Estimate	Direct	Indirect	Induced	Total
Income: Midrange	$363,191	$55,327	$67,313	$485,831
Employee Compensation	$190,996	$25,724	$27,237	$243,955
Proprietor Income	$76,875	$6,156	$6,076	$89,107
Other Property Income	$37,068	$18,371	$25,851	$81,290
Indirect Business Taxes	$58,251	$5,078	$8,149	$71,478
Income: High	$399,510	$60,860	$74,044	$534,414
Income: Low	$326,872	$49,794	$60,582	$437,248

Estimated income impacts by industry are similarly derived from the Table 4 estimates of impacts per 10,000 visitor days. Table 6 contains the effects on industry income for all sectors receiving income of $0.50 or more per visitor day from spending by Lake Davis recreational users. The largest effect on income is in the hotel and motel sector, with a midrange impact of $101,290, and a range of estimates from a low of $91,161 to a high of $111,420. Other sectors experiencing a midrange income impact in excess of $50,000 include gasoline stations ($96,263), food services and drinking places ($69,588), and food and beverage stores ($55,836).

Table 6: Estimated 2005 Income Impacts by Industry

IMPLAN Sector Number	Sector Description	Midrange	High	Low
405	Food and Beverage Stores	$55,836	$61,420	$50,253
407	Gasoline Stations	$96,263	$105,890	$86,637
409	Sporting Goods	$22,089	$24,298	$19,880
431	Real Estate	$14,387	$15,826	$12,948
479	Hotels and Motels	$101,290	$111,420	$91,161
481	Food Services and Drinking Places	$69,588	$76,547	$62,630
509	Owner Occupied Dwellings	$16,758	$18,434	$15,083

Other Impact Measures

Income is the best measure of the contribution of Lake Davis visitor spending to the Plumas County economy, yet other measures might be useful for some purposes. The impact on county output represents the effect on gross sales, but since it includes the value of industry purchases from businesses outside of the county, it is not an appropriate measure of the impact on local income. In addition, although effects on county employment are generated by the IMPLAN model, the jobs created or sustained are neither full-time, not full-time equivalent jobs. County revenues are included in the income impact estimates as a portion of the entry for indirect business taxes.

Estimates for each of these additional impact measures are included in Table 7, with entries for the midrange, high and low estimates of total 2005 visitor days at Lake Davis. Visitor spending generates a total of $829,039 in output (gross sales) within Plumas County, with the estimated impact ranging from a low of $746,135 to a high of $911,942. A total of between 17.0 and 20.7 jobs result from that spending, with a most likely estimate of 18.8 jobs. Plumas County and the City of Portola receive revenues equal to 6.28% of local income (excluding state and federal aid). Thus estimated 2005 local revenue ranges from a low of $27,471 to a high of 33,576, with the estimate for midrange non-resident visitor days equal to $30,523.

Table 7: Estimated 2005 Impacts on Output (Gross Sales), Employment, and Plumas County Revenue

Impact Type	Midrange	High	Low
Output	$829,039	$911,942	$746,135
Employment	18.8	20.7	17.0

| Local Revenues | $30,523 | $33,576 | $27,471 |

Study Results: Local Economic Impacts

Assumptions

Fishery Quality

Successful Eradication

With successful eradication of northern pike from Lake Davis it is assumed that the quality of the fishery will double within four years of project completion. The 2003 angler survey indicated a catch rate of 0.12 trout per hour, while in 2000 the catch rate was 0.28 trout per hour. Although the 2000 catch rate was more than double that of 2003, the average fish caught in 2003 was significantly larger. However, the assumptions that the catch rate will only double, and not until four years following completion of the eradication project, are relatively conservative. It is possible that from the anglers' prospective the quality will more than double and that improvement will be achieved in as little as two years after initial restocking. Earlier recovery of fishery quality increases the local economic benefits of both the successful and failed eradication cases.

Failed Eradication

If eradication is unsuccessful it is assumed that the fishery quality will follow a somewhat different path. Following attempted eradication it is assumed that the quality of the fishery will double within four years of project completion, however after that year the catch rate will decline until at the end of ten years it will have returned to current levels.

Visitor Response to Changes in Fishery Quality

The impact of changes in fishery quality on visitor days depends on the response of anglers to the catch rate and the timing of that response. The Lake Davis angler survey performed by the Center for Economic Development (CED) determined that a 100% increase in the catch rate will lead to a 63.2% increase in visitor days. This is very close to the 64.5% response rate from the environmental economics literature and the 63.2% figure from the survey is used in the economic impact analysis performed for each of the pike eradication and management scenarios. It is also assumed that angler visitor days are determined by the previous year's catch rate. Thus the peak for visitor days will always lag the peak for the catch rate by one year. In addition the angler response rate of 63.2% is used for both an increase and a decrease in fishery quality. (Loomis 2005)

Scenario 1: The Preferred Alternative

Table 8 includes the impacts on Plumas County income of both successful and failed eradication using the method proposed under the preferred alternative. In both cases the lake is unavailable for one year and thus for that year visitor days are assumed to be zero. In the second year visitor days return to their pretreatment levels, growing at a 13% annual rate until they reach a peak at 32,600 in year 6. The actual annual growth rate for

visitor days is higher than 13% and continues beyond year 6 due to growth in population in those areas from which visitors are drawn. [8]

The income impacts are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenarios.[9] The total contribution to Plumas County income for the 22 years is $17.82 million for the successful eradication case, and, $13.74 million and $11.62 million for the two failed eradication cases.[10] For all of the scenarios the failed eradication cases are delineated according whether the attempt is repeated at 11-year intervals (failed/repeat) or done just once (failed/once). All totals are in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $12.39 million, $9.70 million and $8.51 million for the successful and the two failed eradication cases, respectively.[11]

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[8] The annual rate of growth in visitor days is the weighted average of the projected rates of population growth for California, the Northeastern Counties, and Washoe County Nevada. The weights are from the California Department of Water Resources (DWR 2005) survey of angler origin. The projected rates of population growth are from the California Department of Finance (DOF 2005) and the Nevada State Demographer (NSD 2005). Based on this approach regional population growth is projected to increase visitor days at Lake Davis by 1.03% annually.

[9] There are two failed eradication cases: one assuming eradication is a periodic event repeated every 10 years (11 years including the treatment period for the preferred alternative) and another where eradication fails, but is not attempted again within the 22 year period of the analysis. By including the multiple treatment case, the California Department of Fish and Game is not implying that it contemplates periodic treatments on an 11 year cycle. Obviously the intention is for the primary treatment to be successful and both the failed eradication cases are included only for purposes of comparison with scenario 4, the no action alternative.

[10] The income impacts are derived directly from the visitor day estimates. In order for the improvements in fishery quality to generate an increase in visitor days, it is necessary that potential visitors become aware of the changes in catch rate, and for that to occur, it is necessary that they choose Lake Davis as a fishing destination. For that reason it might be argued that there is a degree of uncertainty in the local income impact estimates. It is true that the level of uncertainty is greater than the 100% chance that the lake will be unavailable during the treatment period, however, anglers did return to the lake after the 1998 treatment and are likely to do so again.

[11] For each of the scenarios analyzed the 22 year totals are presented in both undiscounted and discounted form. The discounted totals place greater importance on income received in earlier years, implicitly recognizing the time value of money. A 3% real discount rate is typically used for decisions involving environmental changes and other public goods and is equal to the real interest rate on relatively risk free investments. The real interest rate is the difference between the nominal interest rate and the rate of inflation.

Table 8: Non-Resident Visitor Days and Impact on Plumas County Income for the Preferred Alternative: Successful and Failed Eradication Efforts

	Visitor Day Estimates			Income Impacts		
	With Population Growth			With Population Growth		
Years	Successful	Failed/Repeat	Failed/Once	Successful	Failed/Repeat	Failed/Once
1	0	0	0	$0	$0	$0
2	20,206	20,206	20,206	$490,796	$490,796	$490,796
3	23,066	23,066	23,066	$560,271	$560,271	$560,271
4	26,331	26,331	26,331	$639,581	$639,581	$639,581
5	30,059	30,059	30,059	$730,118	$730,118	$730,118
6	34,314	34,314	34,314	$833,470	$833,470	$833,470
7	34,667	31,440	31,440	$842,055	$763,665	$763,665
8	35,024	28,807	28,807	$850,728	$699,706	$699,706
9	35,385	26,394	26,394	$859,491	$641,104	$641,104
10	35,750	24,184	24,184	$868,343	$587,410	$587,410
11	36,118	22,158	22,158	$877,287	$538,213	$538,213
12	36,490	0	21,632	$886,323	$0	$525,434
13	36,866	22,617	21,118	$895,452	$549,357	$512,959
14	37,245	25,819	20,617	$904,676	$627,122	$500,780
15	37,629	29,473	20,128	$913,994	$715,895	$488,890
16	38,017	33,645	19,650	$923,408	$817,234	$477,283
17	38,408	38,408	19,183	$932,919	$932,919	$465,951
18	38,804	35,191	18,728	$942,528	$854,785	$454,888
19	39,203	32,244	18,283	$952,236	$783,194	$444,088
20	39,607	29,543	17,849	$962,044	$717,600	$433,544
21	40,015	27,069	17,425	$971,953	$657,499	$423,251
22	40,427	24,802	17,011	$981,964	$602,432	$413,202
Total				$17,819,638	$13,742,373	$11,624,605
Net Present Value (3% Real Discount Rate)				$12,386,630	$9,697,774	$8,507,678

Scenario 2

Scenario 2 involves drawing the lake down to its minimum capacity, and as a result, using this eradication method involves loss of recreational use of the lake for a period of three years. Table 9 includes the impacts on Plumas County income of both successful and failed eradication using the method proposed under scenario 2. In both cases the lake is unavailable for three years and thus visitor days are assumed to be zero for those years. In the fifth year visitor days return to their pretreatment levels, growing at a 13% annual rate thereafter until they reach a peak of 32,600 in year 8. As with the preferred alternative the actual annual growth rate for visitor days is higher than 13% and continues beyond year 8 as population grows within the area served by Lake Davis.

As in the case of the preferred alternative, the income impacts are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenario, but also considered is the option of treating the lake just once with this method. The total contribution to Plumas County income for the 22 years is lower than for scenario 1 at $16.19 million for the successful eradication case, and, $11.59 million and

$11.72 million for the failed eradication cases, with all in totals in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $10.92 million, $7.89 million and $8.19 million for the successful and two failed eradication cases, respectively.

Table 9: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 2: Successful and Failed Eradication Efforts

	Visitor Day Estimates			Income Impacts		
	With Population Growth			With Population Growth		
Years	Successful	Failed/Repeat	Failed/Once	Successful	Failed/Repeat	Failed/Once
1	0	0	0	$0	$0	$0
2	0	0	0	$0	$0	$0
3	0	0	0	$0	$0	$0
4	20,624	20,624	20,624	$500,958	$500,958	$500,958
5	23,544	23,544	23,544	$571,872	$571,872	$571,872
6	26,877	26,877	26,877	$652,824	$652,824	$652,824
7	30,681	30,681	30,681	$745,235	$745,235	$745,235
8	35,024	35,024	35,024	$850,728	$850,728	$850,728
9	35,385	32,091	32,091	$859,491	$779,478	$779,478
10	35,750	29,403	29,403	$868,343	$714,194	$714,194
11	36,118	26,941	26,941	$877,287	$654,379	$654,379
12	36,490	0	26,301	$886,323	$0	$638,842
13	36,866	0	25,677	$895,452	$0	$623,674
14	37,245	0	25,067	$904,676	$0	$608,867
15	37,629	23,085	24,472	$913,994	$560,732	$594,411
16	38,017	26,353	23,891	$923,408	$640,107	$580,298
17	38,408	30,084	23,324	$932,919	$730,719	$566,520
18	38,804	34,342	22,770	$942,528	$834,156	$553,069
19	39,203	39,203	22,229	$952,236	$952,236	$539,938
20	39,607	35,920	21,701	$962,044	$872,484	$527,119
21	40,015	32,912	21,186	$971,953	$799,411	$514,603
22	40,427	30,155	20,683	$981,964	$732,459	$502,385
Total				$16,194,237	$11,591,974	$11,719,395
Net Present Value (3% Real Discount Rate)				$10,921,600	$7,893,204	$8,188,873

Scenario 3

Scenario 3 involves drawing the lake down to 48,000 acre feet, and as a result, using this eradication method involves minimal loss of recreational use of the lake. That is because all boat ramps will continue to be usable, and although the lake will not be stocked during year one of this eradication option, some fishing activity will likely continue. Table 10 includes the impacts on Plumas County income of both successful and failed eradication using this method and assuming lake use will be affected for just 50% of year 1. In this case visitor days total 10,000 for year 1 and then return to the current estimated use of 20,000 (plus the effect of population growth) in year 2. As with the other eradication options the improvement in catch rate causes visitor days grow at 13% annually until they

reach a peak in year 6 (five years after completion of treatment), while actual use grows at a higher rate, reflecting population growth in the area served by Lake Davis.

The total contribution to Plumas County income for the 22 years is slightly higher than for scenarios 1 and 2 at $18.06 million for the successful eradication case, and, $14.26 million and $11.87 million for the failed eradication cases, all in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the income impacts of $12.62 million of the successful eradication case, and, $10.12 million and $8.74 million for the failed eradication cases.

Table 10: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 3: Successful and Failed Eradication Efforts

	Visitor Day Estimates			Income Impacts		
	With Population Growth			With Population Growth		
Years	Successful	Failed/Repeat	Failed/Once	Successful	Failed/Repeat	Failed/Once
1	10,000	10,000	10,000	$242,896	$242,896	$242,896
2	20,206	20,206	20,206	$490,796	$490,796	$490,796
3	23,066	23,066	23,066	$560,271	$560,271	$560,271
4	26,331	26,331	26,331	$639,581	$639,581	$639,581
5	30,059	30,059	30,059	$730,118	$730,118	$730,118
6	34,314	34,314	34,314	$833,470	$833,470	$833,470
7	34,667	31,440	31,440	$842,055	$763,665	$763,665
8	35,024	28,807	28,807	$850,728	$699,706	$699,706
9	35,385	26,394	26,394	$859,491	$641,104	$641,104
10	35,750	24,184	24,184	$868,343	$587,410	$587,410
11	36,118	22,158	22,158	$877,287	$538,213	$538,213
12	36,490	11,193	21,632	$886,323	$271,878	$525,434
13	36,866	22,617	21,118	$895,452	$549,357	$512,959
14	37,245	25,819	20,617	$904,676	$627,122	$500,780
15	37,629	29,473	20,128	$913,994	$715,895	$488,890
16	38,017	33,645	19,650	$923,408	$817,234	$477,283
17	38,408	38,408	19,183	$932,919	$932,919	$465,951
18	38,804	35,191	18,728	$942,528	$854,785	$454,888
19	39,203	32,244	18,283	$952,236	$783,194	$444,088
20	39,607	29,543	17,849	$962,044	$717,600	$433,544
21	40,015	27,069	17,425	$971,953	$657,499	$423,251
22	40,427	24,802	17,011	$981,964	$602,432	$413,202
Total				$18,062,534	$14,257,147	$11,867,501
Net Present Value (3% Real Discount Rate)				$12,622,451	$10,124,286	$8,743,499

Scenario 4

Scenario 4, the no action alternative, yields the smallest contribution to Plumas county income. Although there are no years for which visitor days are zero, the postulated declining catch rate attracts fewer visitors each year through year 11. After year 10 it is assumed that the ongoing pike management program successfully halts the decline in the catch rate, but not until the quality of the fishery has declined by 50% from current levels.

As is the case for all of the eradication scenarios, population growth in the areas from which Lake Davis visitors are drawn leads to an increase in annual visitor days, in this case after the minimum is reached in year 11.

The contribution to Plumas County income of spending by Lake Davis visitors is lower than for any of the eradication scenarios. The total for the 22 years is $9.03million in 2005 dollars, while the net present value at a 3% real discount rate is $6.61 million. Even if improved methods of managing northern pike were capable of maintaining the current trout catch rate, all of the pike eradication scenarios result in more income for Plumas County. With base year visitor days at 20,000, and with population growth resulting in an annual increase in visitor days of 1.03%, the total contribution to local income for the 22 year period is $11.93 million, just 67% of the amount generated for the same period using the preferred alternative for pike eradication.

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Table 11: Non-Resident Visitor Days and Impact on Plumas County Income for Scenario 4: No Action Alternative

Years	Visitor Day Estimates		Income Impacts with Population Growth
	Without Population Growth	*With Population Growth*	
1	20,000	20,000	$485,792
2	19,326	19,525	$474,258
3	18,675	19,062	$462,998
4	18,046	18,609	$452,005
5	17,438	18,167	$441,274
6	16,850	17,736	$430,797
7	16,167	17,192	$417,587
8	15,511	16,665	$404,782
9	14,882	16,154	$392,370
10	14,279	15,658	$380,339
11	13,700	15,178	$368,676
12	13,700	15,335	$372,473
13	13,700	15,493	$376,310
14	13,700	15,652	$380,186
15	13,700	15,813	$384,102
16	13,700	15,976	$388,058
17	13,700	16,141	$392,055
18	13,700	16,307	$396,093
19	13,700	16,475	$400,173
20	13,700	16,645	$404,295
21	13,700	16,816	$408,459
22	13,700	16,989	$412,666
		Total	$9,025,747
	Net Present Value (3% real discount rate)		$6,608,624

Economic Impacts by Pike Management Scenario

Successful Eradication vs. Ongoing Pike Management

Table 12 includes the impacts on annual sales, income, employment, and county revenues for each of the eradication scenarios (scenarios 1-3) and the ongoing pike management scenario (scenario 4). It is clear that from the perspective of the Plumas County economy any of the eradication options, if successful, is preferable to the current pike management option. For the 22 year period covered by the analysis average annual gross sales for Plumas County businesses are higher by $682,100 for the preferred option (scenario 1) relative to ongoing pike management. Average annual Plumas County income, employment, and local revenue are also higher by $399,722, 16 jobs, and $25,113, respectively.

The economic advantage of pike eradication is somewhat greater for scenario 3 with average annual gross sales for Plumas county businesses higher than for the pike management option by $700,940 and exceeding that for the preferred option by $18,840. Income, employment, and county revenues are also somewhat higher than for the preferred option. However, the important result is that, because of the long term impact on the quality of the Lake Davis fishery, successful eradication by any of the means under consideration is preferable to the current strategy of pike management alone.

Table 12: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: Successful Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	Scenario Number			
	1	2	3	4
Sales	$1,382,184	$1,256,110	$1,401,024	$700,084
Income	$809,984	$736,102	$821,024	$410,261
Employment	31	29	32	16
Revenue	$50,889	$46,247	$51,583	$25,776

Failed Eradication vs. Ongoing Pike Management

While the results included in Table 12 indicate that successful eradication of pike from Lake Davis would have clear economic advantages for Plumas County, the possibility that any eradication effort might fail must also be considered. In that case pike eradication would be a periodic event (every 11 years) or a one-time effort, with current management techniques employed in the interim. Table 13 includes the impact on Plumas County gross sales, income, employment, and county revenues for each of the failed repeat eradication scenarios. Table 14 includes the economic impacts for a one-time failed eradication effort. For purposes of comparison the management option is also included under scenario 4 in both Tables 13 and 14.

The results clearly indicate that repeating a failed eradication effort is preferable to the current strategy of pike management alone. Using the preferred alternative, average

annual gross sales for Plumas County businesses are $365,846 higher than for the management option. Average annual Plumas County income, employment, and local revenue are also higher by $214,392, 8 jobs, and $13,470, respectively. As in the case of successful eradication, the economic advantages of scenario 3 over ongoing pike management are somewhat greater. With this scenario estimated annual gross sales of Plumas County businesses exceed those associated with scenario 4 by $405,775 and are $39,929 higher than for the preferred alternative. Income, employment, and county revenues are also somewhat higher than for the preferred option. [12]

Table 13: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: Repeat Failed Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	Scenario Number			
	1	2	3	4
Sales	$1,065,930	$899,134	$1,105,859	$700,084
Income	$624,653	$526,908	$648,052	$410,261
Employment	24	20	25	16
Revenue	$39,245	$33,104	$40,715	$25,776

With the one-time failed eradication cases included in Table 14 there is very little difference in the annual impacts on sales, local income, employment, and local government revenue. Average annual impacts range from $901,665 to $920,505 for gross sales; from $528,391 to $539,432 for income; from 20 to 21 jobs: and from $33,197 to $33,891 for local government revenue. As in the repeat failed eradication cases, the average annual impacts exceed those of scenario 4, using ongoing pike management alone.

Table 14: Impacts on Plumas County Output (Gross Sales), Income, Employment, and County Revenue: One-Time Failed Eradication Scenarios (Scenarios 1-3) and Ongoing Pike Management (Scenario 4)

Average Annual Impact on Plumas County:	Scenario Number			
	1	2	3	4
Sales	$901,665	$909,017	$920,505	$700,084
Income	$528,391	$532,700	$539,432	$410,261
Employment	20	21	21	16
Revenue	$33,197	$33,468	$33,891	$25,776

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[12] It might be argued that the advantages of a failed eradication attempt are overstated due to the assumptions regarding the period of time that the quality of the fishery can be sustained. For each of the scenarios it is assumed that the quality of the fishery improves for the first four years following the eradication project. Yet, there is clear evidence that the catch rate for Lake Davis trout had declined beginning three years after the restocking that followed the 1997-98 effort. However, the assumption of an additional year of sustained growth is reasonable since it is likely that this time around, if pike reappear in the lake, DFG will immediately implement those management techniques that have proven to be most effective. The assumption of an additional year of sustained fishery quality is simply a reflection of the value of previous management experience.

Conclusions

Ranking the alternative methods of dealing with the northern pike problem in Lake Davis is relatively straightforward when the sole criterion is the economic impact on the Plumas County economy. The conclusion based on the analysis contained within this report is that eradication is preferable to the current management program. Even a failed attempt at eradication (repeat or one-time) yields a better economic outcome for Plumas County. Among the alternative methods of eradication proposed scenario 3 yields the greatest local economic benefits, although scenario 1, the preferred alternative, is a close second. Both are preferable, on the basis of economic impact (in all but the one-time failed eradication case), to scenario 2 since the latter implies the loss of the recreational use of the lake for a full three years.

The choice between scenarios 1 and 3 is a difficult one and one that cannot be made on the basis of economic impact alone. For the successful eradication case there is a difference of just $18,840 in the annual effect on gross sales and a difference of $11,041 in the estimated impact on annual local income. While the differences are greater for the repeat failed eradication case, the disparity is insignificant relative to the gap between the successful and failed eradication cases. If eradication were to be unsuccessful, and were to be repeated periodically (every 11 years in this case), under scenario 3, annual business sales would average $295,166 less than for the successful case. In addition, annual income would be lower by an average of $172,972. The disparity between impacts on gross business sales and local income are likewise significant for scenario 1, the preferred alternative. Under this option a failed repeat eradication effort would reduce average annual gross sales and local income by $316,254 and $185,330, respectively.

On the basis of economic impact on the Plumas County economy, a pike eradication effort by any of the proposed methods is preferable to continuing the current pike management program alone. And, since the differences in the impacts among the alternative scenarios are insignificant (at least for scenarios 1 and 3) relative to the local economic cost of a failed eradication attempt, the choice of an eradication method should be made on the basis of which one has the greatest probability of success.

References

California Department of Fish and Game (DFG 2003), *History of Lake Davis Fishery and Management*, Portola field Office, Draft Report, December 15, 2003

California Department of Fish and Game (DFG 2003), *Managing Northern Pike at Lake Davis a Plan for Year 2000: Three Year Report*, September, 2003

California Department of Fish and Game (DFG 2005), *Notice of Preparation of a Draft Environmental Impact Report*, September 2005

California Department of Finance (DOF 2005), Population growth projections for California Counties through 2030, http://www.dof.ca.gov/HTML/DEMOGRAP/DRU_Publications/Projections/P3/P3.htm, December, 2005

California Department of Transportation (DOT 2005), *California: 2005-2025 County-Level Economic Forecast*, http://www.dot.ca.gov/hq/tpp/offices/ote/forecast2005/2005%20all%20county%20Forecast%20Book.pdf

California Department of Water Resources (DWR 2003a), 1986 Lake Davis Creel Census, Memorandum to Kathy Hill dated November 20, 2003

California Department of Water Resources (DWR 2003b), 1998 Lake Davis Creel Census, Memorandum to Kathy Hill dated October 8, 2003

California Department of Water Resources (DWR 2003c), 2001 Lake Davis Creel Census, Memorandum to Kathy Hill dated October 8, 2003

California Department of Water Resources (DWR 2005), Angler origin at Lake Davis 1986-2004, provided by email November, 2005

City of Portola Finance Office, Interview on with Susan Scarlett, August 21, 2006

Graham-Tomasi, T., Adamowicz, W.L. and Fletcher, J.J. (1990), *Errors of Truncation in Approximation to Expected Consumer Surplus*, Land Economics, Vol. 66, No.1, 1990, p. 50-55

Kerkvliet, Joe and Clifford Nowell (2000), *Tools for Recreation Management in Parks: the Case of the Greater Yellowstone's Blue Ribbon Fishery*, Ecological Economics, Vol. 34 (2000), p. 89-100.

Lee 2001, *Northern Pike Control at Lake Davis, California*, American Fisheries Society, 2001

Loomis 2005, *The Economic Value of Recreational Fishing & Boating to Visitors and Communities Along the Upper Snake River*, Colorado State University, Fort Collins, May 2005

Minnesota IMPLAN Group (MIG 2005), IMPLAN model using 2001 data, January 2005

Nevada State Demographer (NSD 2005), Projected population growth for Washoe County, Nevada, http://www.nsbdc.org/demographer/pubs/pop_increase.html, December 2005

Plumas County, Auditor/Controller's Office (PCAC 2006), Interview regarding property and sales tax allocations to Plumas County and the City of Portola, August 17, 2006

Plumas County Budget, http://www.countyofplumas.com/admin/2005-2006_budgetbook.pdf

Save Lake Davis Task Force Steering Committee and the California Department of fish and Game (SLDTFSC/DFG 2000), *Managing Northern Pike at Lake Davis: A Plan for Y2000*, January 2000

U.S. Census Bureau (USCB) 2005, www.census.gov

U.S. Census Bureau (USCBa) 2005, http://quickfacts.census.gov/qfd/states/06000.html

United States Forest Service (USFS 2005), Lake Davis campground use from 1996 through 2005, provided by phone October-November 2005

Appendix A

Resource Valuation

As the previous economic impact analysis has shown, improving the quality of the Lake Davis fishery, by eradicating the Northern Pike, has the potential to increase the local economic benefits of Plumas County. By improving the quality of the fishery we can expect an increase in visitation and expenditures which results in an increase in income to local businesses such as restaurants, gas station owners, motel owners, and other retail businesses. The local community in-turn also benefits as the increase in economic activity also leads to increases in employment, and local government tax revenue. However, expenditures by visitors which contribute income to the local community are costs rather than benefits to the local visitor.

In conventional economics it is generally accepted that measures of economic value should be based on the preferences of individuals. More specifically, the economic value of a resource is measured by the maximum willingness to pay to obtain a good or service. Dollars are a universally accepted measure of economic value because the amount that people are willing to pay for something reflects how much of all other for-sale goods and services they are willing to give up to get it. Under most circumstances individuals must pay an actual price or incur expenses to obtain the good. So, to determine the value that visitors place on the Lake Davis resource, economists estimate consumer surplus or net willingness to pay, which is defined as the difference between the maximum an individual is willing to pay to fish at Lake Davis versus the expenditures paid to fish Lake Davis. For example, if a visitor is willing to pay up to $90 to fish at Lake Davis and incurred $50 in expenses while traveling to and fishing Lake Davis, then the net economic value that the visitor places on Lake is $40. By taking the summation of the consumer surplus or net willingness to pay by all visitors to Lake Davis, we can estimate the value that visitors place on the Lake Davis resource. With improvement in the quality of the fishery, we would expect an increase in visitation and willingness to pay, resulting in an increase in the value of the Lake Davis resource.

Estimation of the value of Lake Davis is accomplished using a travel cost model. The use of travel cost to estimate the demand for recreational sites was first suggested by H. Hotelling in the late 1940's. The model was further developed by Knetsch and Clawson in the 1950's and 1960's and has since gained broad acceptance among resource economists. The literature in resource and environmental economics contains numerous studies using variations on the travel cost model.

This family of approaches to valuing a resource is based on the idea that the cost of getting to a recreational site is a measure of the value individuals place on its use. A demand curve is generated from the various travel costs and the associated number of trips. It is fundamental to economic theory that the higher the price of a good or service the smaller the quantity demanded. In the vernacular of the travel cost model this means that as travel cost increases, as it does with distance from the site, the smaller the number

of trips made annually. The total value of the resource is estimated as the area under the generated demand curve but above the average travel cost for all surveyed users.

The individual travel cost method was chosen for the study utilizing surveys to collect data specific to each individual visitor's travel distance and demographic information. Individuals were asked about the distance traveled, travel time, the expenses they incurred traveling, the length of their trip, how much time they spent at the site, the quality of their recreation experience at the site, their perception of the site's environmental quality, characteristics of the site, and residence (used to determine whether they reside in a rural of urban area).

Data Sources

Surveys and visitor counts were conducted at Lake Davis on 13 days in September and October of 2005 and for 12 days during May, June, and July of 2006. Over that time interval 238 parties were surveyed representing 477 individual visitors. (See Appendix B for the actual form used). Interviews were conducted at four boat launch points including Honker Cove, Mallard Cove, Eagle Point, and Camp 5. Some refused to be surveyed, but the majority of those approached willingly participated.

There was an average of 2.01 individuals per interviewed party with 97.4% of those interviewed visiting from outside of Plumas County. The duration of the average visit was 3.14 days, while the average visiting party makes 2.09 trips to Lake Davis annually. Most visitors (87.5%) listed the primary purpose of their visit as fishing, with 5.73% visiting friends and the remainder traveling to the area for business or other recreation. Just fewer than 70% of surveyed visitors stayed in the local area, with 45.96% of those staying locally utilizing campground facilities, 18.01% staying in hotels or motels, 14.91% staying with friends, and the remaining 21.12% listing "other", primarily second homes.

Wage data by county is from the 2000 Census (USCB 2005). Conversion to hourly wage rates is accomplished by dividing by 1948, the average annual hours worked (USCB 2005). Driving distance is calculated from the origin ZIP codes to the destination ZIP codes and cost per mile was obtained from the AAA website.

The Model and Variables Included

The travel cost model specifies a relationship between the number of annual visitor days per travel party from a particular origin to a particular destination and the cost of the trip (travel cost). There are also four dummy variables included, one specifying whether the county of origin is urban or rural, and three that determine whether the visitor is staying at their primary residence, in a cabin or second home, staying with friends, or staying somewhere else, such as campsite or a motel/hotel. The final dummy variable specifies whether the primary purpose of visitation was to fish or to do something else.

Travel cost includes three elements. It is defined as the sum of the direct cost of the trip, the opportunity cost in terms of lost wages for the duration of the trip, and the on-site preparation time for boat launching or getting to a site for fishing. Each of these elements of travel cost is estimated in the conventional manner. Direct travel cost is equal to the cost per mile (56.2 cents) times the number of miles required to make the round trip to the site. Opportunity cost is calculated as 30 percent of the average hourly wage rate for the county of origin times the number of hours of travel time. The cost of preparation time is computed in the same manner, and for all sites is equal to one-half hour times 30 percent of the hourly wage rate. Where there is more than one individual in the fishing party it is assumed that direct travel cost is shared equally among the members.

Where a visitor chose to stay was also accounted for in the analysis. Home is equal to one if a visitor is staying in their primary home, while if a visitor stays elsewhere a value of zero is assigned. Cabin is equal to one if a visitor is staying in a cabin or second home, while if a visitor stays elsewhere a value of zero is assigned. Friend is equal to one if a visitor is staying with friends, while if a visitor stays elsewhere a value of zero is assigned. The coefficient for the cabin and friend variables are expected to be positive because we believe that a visitor is likely to stay longer or visit more often if friends or cabin are present. Conversely, the coefficient for the home variable is expected to be negative because we believe that a visitor is likely to stay over less or visit less if they must drive back to their primary residence. We also believe that the coefficient for the fish variable will be positive, given that fishing is the most popular activity in the area of study.

Whether an area is urban or rural is an important determinant of resident participation in fishing activity. Compared to residents of rural areas, there is a lower probability of an urban resident being a frequent angler (USFWS 1996). The difficulty is in distinguishing rural from urban areas. The definition adopted here is that a county with a population over 750,000 and where 30% or more of the county population lives in a city of more than 100,000 residents is urban. If the ZIP code reported on the survey entry is in an urban county the observation is assigned a zero, while if it is in a rural county a value of one is assigned.

Estimated Equation

The following equation was estimated in log-log form using ordinary least squares.

$$Ln(Visitordays/Pop_{ij}) = a + b\ Ln(TC_{ij}) + c\ Cabin_j + d\ Friends_j + e\ Home_j + f\ Fish_j + g\ Rural_i$$

Where, for each of the 279 observations representing 11,410 visitor days:

$Ln(Visitordays_{ij}/Pop_{ij})$ is the dependent variable. For each observation it represents the number of visitor days by a traveling party from county of origin, i to destination, j (Lake Davis). It is equal to the number of individuals in the

fishing party multiplied by the length of stay multiplied by the number of annual visits, divided by the population (in millions) of the county of origin.

TC_{ij} = travel cost from ZIP code origin, i to Lake Davis (j)   =
($0.562*round trip distance in miles)/number in fishing party
+ 0.3*hourly wage rate*round trip travel time
+ 0.3*hourly wage rate*0.5 hours

$Cabin_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is utilizing a cabin or second home (1) or staying someplace else (0).

$Friend_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is staying with a friend (1) or staying someplace else (0).

$Home_j$ = 0 or 1 and is a dummy variable indicating whether a visitor is staying at their primary residence (1) or staying someplace else (0).

$Fish_j$ = 0 or 1 and is a dummy variable indicating whether a visitor's primary purpose for visiting is to fish (1) or something else (0).

$Rural_i$ = 0 or 1 and is a dummy variable defining the county of origin as rural (1) or urban (0)

a – g are the coefficients to be estimated

Coefficient Estimates

The estimated equation is:

Ln(Visitordays/pop) = -6.260177 - 1.280362Ln(TC) + 1.011768Cabin + .7397405 Friend + -1.072858Home + .8982976Fish + 1.348624Rural

Table A1: Regression Coefficients, Standard Errors, and T-Values[13]

Variable	Coefficients	Standard Error	t Stat
Intercept	-6.260177	.6866137	-9.12*
Ln(TC)	-1.280362	.1160389	-11.03*
Cabin	1.011768	.3219867	3.14**
Friend	.7397405	.3675501	2.01**
Home	-1.072858	.2407894	-4.46*
Fish	.8982976	.353026	2.54**
Rural	1.348624	.2766694	4.87*

[13] *   Indicates statistically significant variables at the 1% level or better.
** Indicates statistically significant variables at the 5% level or better.

Table A1 contains the coefficients, their respective standard errors and t-values. Table A2 includes the adjusted R-square and F-value for the regression.

Table A2: Regression Statistics: Adjusted R-Square and F-Value

Regression Statistics	
Observations	279
R Square	0.4955
Adjusted R Square	0.4844
F(6, 272)	44.53

Table A1 shows that there is a relationship, significant at the 1% confidence level, between the visitor day variable and the variables for travel cost, staying in a primary residence and counties of origin designated rural. As expected, visitor days and travel cost are negatively related, while visitor days and rural counties of origin are positively related. Visitor days and staying in a primary residence are negatively related. Staying with friends, staying in a cabin or second home, and primary purpose for visiting is to fish are significant and positively related to visitor days at the 5% level.

The 2005 Value of the Lake Davis Fishery Resource to Freshwater Anglers

Using the statistical results from the model and the visitor day use from the U.S. Forest Service (USFS), California Department of Fish and Game (DFG), and the Center for Economic Development (CED) allows estimation of the current (2005) value of the recreation opportunities at Lake Davis. To calculate net WTP on consumer surplus per visitor day for the log-log functional form, we utilize the approximation developed by Graham-Tomasi, Adamowics and Fletcher (1990), if $b < -1$:

$$CS/Q = (1/(b+1) * TC*Q),$$

where Q represents the actual per capita visitor days and TC is the travel cost corresponding to the sample average per capita visitor days. The visitors net WTP per day from the travel cost model is $59.88. Given that nearly 87.5% of visitors indicate that the primary purpose of visiting Lake Davis is fishing, the value of $59.88 per visitor day likely captures the value fisherman place on Lake Davis trout. The estimate of $59.88 per visitor day is consistent with the estimated value of other trout fisheries cited in the environmental and resource economics literature. For example, Loomis (2005) has determined that trout fisheries in the intermountain west to be roughly equal to $50 per day. The 2005 net annual economic value of Lake Davis resource to visitors is the product of the annual number of visitor days and consumer surplus per visit. Since the range of visitor days derived by the USFS, DFG, and CED varies from 17,101 to 26,170, the estimated net economic value falls somewhere between $1,024,008 and $1,567,060, with a probable value of $1,425,743 (based on 23,810 visitor days).

The Impacts on the Value of the Lake Davis Fishery Resource for the Preferred Alternative and No Action Alternative Scenarios

Table A3 includes the impacts on the net resource value of Lake Davis of both successful and failed eradication using the method under the preferred alternative, scenario 1, and the no action alternative, scenario four. We once again assume that visitors respond to changes in fishery quality, with a 100% increase in catch rate leading to a 63.2% increase in visitor days. It as also assumed that angler visitor days will always lag the peak catch rate by one year. For simplicity, we also assume that net WTP per visitor day, $59.88, does not vary as fishery quality varies.[14]

Table A3: The Value of the Lake Davis Fishery Resource under Scenarios 1 and 4

	Visitor Days with Population Growth			Resource Value		
	Scenario 4: Management Only	Scenario 1: Eradication		Scenario 1: Eradication		Scenario 4: Management Only
Years		Successful	Failed	Successful	Failed	
1	23,810	0	0	$0	$0	$1,425,743
2	23,245	24,055	24,055	$1,440,428	$1,440,428	$1,391,892
3	22,693	27,460	27,460	$1,644,329	$1,644,329	$1,358,845
4	22,154	31,348	31,348	$1,877,094	$1,877,094	$1,326,582
5	21,628	35,785	35,785	$2,142,808	$2,142,808	$1,295,086
6	21,115	40,851	40,851	$2,446,136	$2,446,136	$1,264,337
7	20,467	41,271	37,429	$2,471,331	$2,241,266	$1,225,568
8	19,839	41,696	34,294	$2,496,786	$2,053,554	$1,187,987
9	19,231	42,126	31,422	$2,522,503	$1,881,564	$1,151,559
10	18,641	42,560	28,791	$2,548,484	$1,723,979	$1,116,248
11	18,070	42,998	26,379	$2,574,734	$1,579,591	$1,082,020
12	18,256	43,441	0	$2,601,253	$0	$1,093,165
13	18,444	43,889	26,925	$2,628,046	$1,612,298	$1,104,424
14	18,634	44,341	30,737	$2,655,115	$1,840,529	$1,115,800
15	18,826	44,797	35,088	$2,682,463	$2,101,067	$1,127,293
16	19,020	45,259	40,055	$2,710,092	$2,398,486	$1,138,904
17	19,216	45,725	45,725	$2,738,006	$2,738,006	$1,150,635
18	19,414	46,196	41,895	$2,766,208	$2,508,692	$1,162,486
19	19,614	46,672	38,386	$2,794,700	$2,298,583	$1,174,460
20	19,816	47,152	35,172	$2,823,485	$2,106,071	$1,186,557
21	20,020	47,638	32,226	$2,852,567	$1,929,682	$1,198,778
22	20,226	48,129	29,527	$2,881,948	$1,768,067	$1,211,126
			Total	$52,298,517	$40,332,230	$26,489,494
Net Present Value (3% Real Discount Rate)				$36,353,285	$28,461,815	$19,395,526

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[14] It should be noted that there is a vast literature that indicates that WTP estimates are positively related to improvement in catch rates (see Loomis (2005) Kerkvliet and Nowell (2000)). Thus, the estimates of economic value of the Lake Davis Resource will be understated in scenarios in which catch rate improves and overstated in scenarios in which catch rate worsens.

Scenario 1: The Preferred Alternative

Once again, whether the treatment method is successful or the fails the lake is unavailable for one year and thus for that year visitor days are assumed to be zero. In the second year visitor days return to their pretreatment levels, growing at a 13% annual rate (baseline values). The actual annual growth rate for visitor days is higher than 13% and continues beyond year 6 due to growth in population in those areas from which visitors are drawn.

The scenario 1 impacts on the value of the Lake Davis fishery resource are included for a 22 year period in order to extend the analysis for two treatment cycles under the failed treatment scenario. The total net economic value of the Lake Davis resource for the 22 years is $52.30 million for the successful eradication case and $40.33 million for the failed eradication case. Discounting at a 3% real discount rate results in a total net present value for the net economic value of the Lake Davis resource of $36.35 million and $28.46 million for the successful and failed eradication cases, respectively

Scenario 4: No Action Alternative

Under scenario 4 there are no years for which visitor days are zero, however the postulated declining catch rate attracts fewer visitors each year through year 11. After year 10 it is assumed that the ongoing pike management program successfully halts the decline in the catch rate, but not until the quality of the fishery has declined by 50% from current levels. As is the case for all of the eradication scenarios, population growth in the areas from which Lake Davis visitors are drawn leads to an increase in annual visitor days, in this case after the minimum is reached in year 11.

The total net economic value of the Lake Davis resource with scenario 4 for the 22 years is $26.49 million in constant 2005 dollars. Discounting at a 3% real discount rate results in a total net present value for the net economic value of the Lake Davis resource of $19.40. Scenario 4, the no action alternative, clearly yields the smaller value to the Lake Davis resource compared to either a successful or failed attempt of eradication under scenario 1.

Appendix B

The Center for Economic Development at California State University, Chico, is conducting an economic impact study, funded by the California Department of fish and Game, of Lake Davis recreational activities on the Plumas County economy. All responses to questions will be kept strictly confidential.

1. Where is your place of residence?

      City, State, ZIP   _____

2. What is the primary purpose of your visit to this area?

      a) Business _____
      b) Tourism or visiting friends _____
      c) Fishing _____
      d) Other recreation _____

3. Approximate travel time (one-way)? _____

4. Are you staying locally?   Yes _____   No _____

5. Length of stay (days)? _____

6. Annual number of trips to Lake Davis? _____

7. If you will (or did) stay overnight where will (or did) you stay?
(Check as many as applicable with the number of days at each)

      a) Hotel/motel _____
      b) Friends/relatives _____
      c) Camping _____
      d) Other (Please Specify) _____

8. If Lake Davis were unavailable would you have traveled to the area?

      a) Definitely yes _____   c) Unlikely _____
      b) Probably _____   d) Definitely not _____

9. What are (will be) your total local expenditures on your trip to this area?

      a) Restaurant Meals $_____   d) Fishing related $_____
      b) Lodging $_____   e) groceries $_____
      c) Transportation $_____   f) Other local retail $_____

10. Are you aware of the presence in Lake Davis of the Northern-Pike, a non-native, predatory fish?

      Yes _____ No _____

11. If yes, does that knowledge affect the number of trips you make to Lake Davis Annually?

      Yes _____ No _____   Decrease? _____ Increase? _____

12. Do you usually catch your daily limit?   Yes _____ No _____

13a. If your answer to the previous question was no, would you fish here more often if you caught twice as many fish daily?

      Yes _____ No _____

13b. How many additional trips would you make each year? _____

14a. If you answer to question 12 is yes, would you fish here less frequently if you caught one-half as many fish daily?

      Yes _____ No _____

14b. If so, how many fewer trips per year? _____

Appendix C

Summary of Portola Business Surveys

When Surveys Were Conducted
Surveys of Portola businesses were conducted in late April and early May over a total of three days including attempts at contacting those business owners not responding to the first round of calls

Businesses Surveyed
Businesses were surveyed in the lodging, eating and drinking places, and grocery and other retail sectors. A total of 23 businesses were included in the survey.

Response Rate
Of the 23 businesses included in the surveys, 13 did not respond either because there was no answer, they refused to answer, or phone numbers were changed and no new numbers were available. Of the 10 responding, two were in business only one year and therefore could offer no information on the effects of the 1998 eradication effort. Only five of the contacted businesses were able to answer all of the questions in the survey but eight of the respondents provided enough information for the surveys to be of some use. The description of the results includes those eight responses.

Results
The average length of time the respondents were in business was 19 years and currently they have an average of 6.45 employees. In 1998 they had an average of 4.83 employees. They estimate that 13.2% of their sales are to individuals whose primary destination is Lake Davis. During the 1998 eradication effort the average decrease in sales for those eight businesses was 8.75% with the duration of the loss averaging 9.66 months. Of the affected concerns only one laid off employees at the time with one full-time worker and three part-time workers losing their jobs. None of the surveyed businesses reported closing for any part of the year.

Appendix I, Attachment 2

Analysis of Statewide Economic Impacts

Lake Davis
Northern Pike Eradication Project EIR/EIS

Statewide Economic Analysis

Prepared by

ENTRIX, Inc.

Prepared for

California Department of Fish and Game

August 2006

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Acronyms

AFR	Alternatives Formulation Report
CPFV	commercial passenger fishing vessel
CSUC	California State University, Chico
CVP	Central Valley Project
Delta	San Francisco Bay/Sacramento-San Joaquin Delta
DFG	California Department of Fish and Game
DMC	Delta-Mendota Canal
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
ESA	Endangered Species Act
I-O	input-output
M&I	municipal and industrial
SWP	State Water Project
SWRCB	State Water Resources Control Board
USFS	U.S. Forest Service

I-2   STATEWIDE ECONOMIC ANALYSIS

I-2.1   Introduction and Background

California is home to hundreds of freshwater streams, rivers, and reservoirs, as well as saltwater or brackish water bays and estuaries. These water bodies and adjacent lands provide many forms of recreation activity such as fishing, swimming, sightseeing, boating, picnicking, and relaxing. They also foster a number of important natural resources, including the State's native fisheries. Statewide water supplies also help fuel one of the nation's largest agricultural industries and provide drinking water to millions of residents. All of these water-dependent activities, in turn, represent an important source of economic livelihood to those who depend on it.

California is also home to many invasive plant, mammal, and fish species. From a biological perspective, these species cause serious damage throughout the State and nationwide. One of these species, the northern pike (*Esox lucius)* is an aggressive fish that feeds on many other species, including trout, salmon, and steelhead. It is an invasive species in California, although not in other parts of the country. In that sense, it differs somewhat from the zebra mollusk, mitten crab, and other aquatic species which have foreign origins. Nonetheless, the potential physical and economic impacts of the northern pike in California are as real as those from foreign species.

The northern pike was discovered in California in 1988 at Frenchman Lake in Plumas County (Lee 2001). Following the successful eradication of the pike at Frenchman Lake, the species was discovered in Lake Davis in 1994. It is believed that the pike were illegally introduced into the lake. Since that initial discovery, the pike population has expanded at Lake Davis, even with the implementation of a number of management strategies by the California Department of Fish and Game (DFG).

In October 1997, DFG treated Lake Davis with rotenone, a piscicide, in an attempt to eradicate the northern pike. Restocking the lake with trout commenced in 1998. However, pike were rediscovered in 1999, and their numbers have increased since that time.

Effects of introduced northern pike in Alaska suggest that the species has the potential to cause irreversible environmental impacts and become the dominant fish species by preying on native fish species (California Agricultural Statistical Service 2001–2005). The aquatic environments in parts of the Feather and Sacramento Rivers and the San Francisco Bay/Sacramento-San Joaquin Delta (Delta) offer many environmental characteristics that match the preferred habitat of the pike. The risk of pike escapement from Lake Davis and establishment of viable populations of the pike in these and other areas throughout California has risen since 1999 due to the increasing number of pike number at Lake Davis.

Because of its predatory nature, the pike is considered a serious threat not only to the trout fishery in Lake Davis, but also to downstream fisheries should it escape from Lake Davis. These concerns extend through the Delta and beyond. Because the pike are considered a threat to anadromous salmon populations, there is the potential that it could affect the number of salmon migrating to the ocean, and thus, the number of salmon to spawn in the future. There are also potential impacts on other protected species, such as the protected Delta

Smelt. Due to these potential biological impacts, there could also be indirect effects on statewide water supplies resulting from possible management actions that would be undertaken in response to pike escapement.

In an effort to remove the northern pike from Lake Davis and eliminate the risk of pike escapement, DFG has proposed to implement a new pike eradication effort. DFG and the U.S. Forest Service (USFS), are preparing a joint Environmental Impact Report/Environmental Impact Statement (EIR/EIS) for the proposed Lake Davis Pike Eradication Project. The Alternatives Formulation Report (AFR) (DFG 2006a) discusses several potential alternatives. This study addresses the potential statewide economic impacts of not implementing this project and the potential for the pike escaping from Lake Davis.

I-2.2   Scope of Analysis

This study corresponds to the economic analysis of statewide impacts of the No Action/No Project alternative of the EIR/EIS under the assumption that pike would escape from Lake Davis and become established downstream. This study does not evaluate the risk (or probability) of pike escapement, nor does it address the potential for illegal planting of pike in other parts of the State. The types of economic impacts considered here included changes in economic output, income, and employment, as well as change in the net economic values (or consumer surplus values) attributed to recreation; this study does not evaluate the fiscal impacts to local jurisdictions. The two primary drivers of statewide economic impacts are: (1) potential physical changes in recreational/sport and commercial fisheries throughout California; and (2) changes in state and federal water operations, specifically water exports from the Delta. Should the pike escape, there are possible impacts to many recreational and commercial fisheries downstream of Lake Davis, extending to marine waters off the California coast. Moreover, should the timing or quantity of Delta water exports be changed in order to accommodate for possible effects of the pike on listed species or to prevent movement of pike downstream of the Delta, the availability of agricultural and municipal and industrial (M&I) water throughout the State could be reduced. Because it is extremely speculative to forecast the potential physical effects of pike escapement, however, this study relies on a set of assumptions reflecting hypothetical scenarios of potential physical impacts that could occur if pike were to escape from Lake Davis.

I-2.3   Conceptual Framework

I-2.3.1   Overview of Economic Impacts from Invasive Species

Invasive species are associated with many serious adverse impacts, including reduced biodiversity because of the reduction or extinction of species that serve as prey to the invasive species, changes in ecosystems, and related changes in agriculture, forestry, fisheries, and other commercial sectors (Lovell and Stone 2005). Lovell and Stone (2005) report that about 400 of 958 threatened or endangered species listed under the Endangered Species Act (ESA) are at risk primarily because of predation by and competition with invasive species.

Pimentel, Zuniga, and Morrison (2004) report that 138 alien fish species have been introduced into the United States, including 56 in California (Pimentel et al. 2004). They also report that 44 native species of fish are threatened or endangered by alien-invasive fish, which often alter aquatic ecosystems. In some cases, these changes have caused reduced numbers or extinction of native species.

In the United States, economic damages from alien invasive species and the cost of their control are estimated at more than $137 billion per year (Pimentel 2003). That figure includes $5.4 billion for damages and control costs of invasive fish. The total figure is asserted to be low because it does not account for the extensive ecosystem damage cause by these species and which are not measurable utilizing conventional market-based metrics (Lovell and Stone 2005).

Several authors have pointed out that the costs of the invasive species extend beyond control costs and include also effects on native ecosystems and human populations which depend on such ecosystems (Perrings et al. 2000). Ciruna, Meyerson, and Gutierrez (2004) point out that economic impacts include effects on both market and nonmarket products and services (Ciruna et al. 2004). Market impacts refer to production losses such as decreases in fisheries, reduced availability of water for industries and others, and declines in property values. Nonmarket impacts may include damages to ecosystems and resultant changes in scenery and other services provided by those systems. Metrics to measure such values are not market based and require instead one or more nonmarket valuation techniques (refer to Layman et al. 1996 for example of the use of these approaches in valuing a fishery).

I-2.3.2 Overview of Economic Impacts from Pike Escapement

As noted above, the two primary drivers of economic impacts associated with pike escapement are expected to be reductions in recreational and commercial fisheries and water exports from the Delta. A flowchart outlining the conceptual approach taken to estimate statewide impacts is shown in Figure I-2-1, which is described below.

Assuming pike escape from Lake Davis and prey on other fisheries through Northern California and the Delta, the counts of desirable fish would likely decline and could result in a reduction in both recreational and commercial fishing in response to reduced catch rates and fish quality. The economic impacts from declines in recreational fishing will depend on many factors, discussed in the following section, including the magnitude of reduced expenditures on fishing trip expenses, such as bait, tackle, food, fuel, and lodging. Commercial fishing activity and harvests would also be expected to decline because of reduced fish counts, as well as potential mandated regulatory reductions in allowed harvests resulting from declining numbers of listed steelhead, salmon, Delta Smelt, and other protected species.
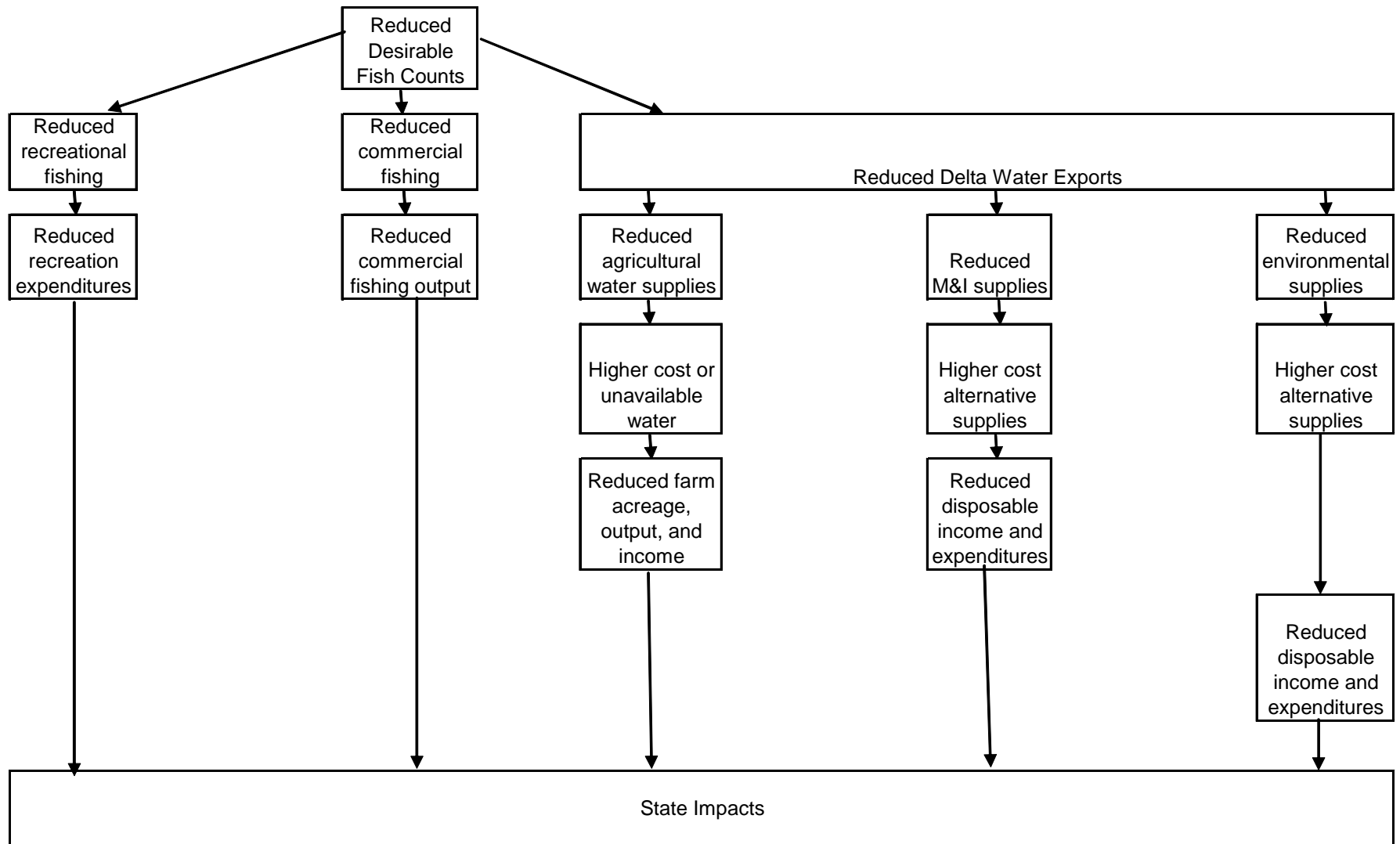
Figure I-2-1. Conceptual Overview of Statewide Economic Impacts from Pike Escapement

Pike escapement also has the potential to affect the timing or quantity of water exports from the Delta. The Delta is the primary fresh water source for the San Francisco Bay and also supplies water to several communities in the local area. In addition, it helps supply drinking water to nearly 25 million people in Central and Southern California and provides irrigation water for more than 3 million acres of highly productive farmland in the Central Valley. Any reductions in Delta water exports to control water quality and outflow needs for the San Francisco Bay are controlled by the State Water Resources Control Board (SWRCB) (DWR 2006a).

If an established pike population in the Delta causes measurable declines in the counts of Delta Smelt or other listed species, export restrictions are likely (Paul Marshall, California Bay-Delta Authority, pers. comm. April 13, 2006). Moreover, any pike-related restrictions on Delta exports would be in addition to those that typically occur under normal operations. In a recent study, it was found that M&I CVP water service contract allocations would be less than 75 percent in 13 of 72 years, assuming a Year 2020 level of development (USBR 2005). In four of those 13 years, irrigation CVP contractors would receive no water and in two other years they would receive less than four percent of contract amounts. Consequently, any Delta export reductions associated with establishment of the pike would potentially compound the impacts caused by shortages due to climate or project operations. In addition, restrictions on Delta water exports may be enacted in an effort to control the spread of pike to other parts of California via the Delta-Mendota Canal (DMC).

I-2.3.3   Regional versus Statewide Impacts

I-2.3.3.1 Geographical Considerations

As noted, this is a *statewide* economic impact analysis; as such, the analysis focuses on the economic effects on the State as a whole. However, it should be noted that the magnitude of potential economic impacts would vary across the different regions of the State, depending primarily on the location of the direct physical and economic impacts. The geographical considerations related to the potential drivers of statewide economic impacts are discussed below.

I-2.3.3.2 Recreational Activities – Substitution Effects

Pike have the potential to affect many fisheries downstream of Lake Davis, including the middle fork and main stem of the Feather River, Lake Oroville, Sacramento River, the Delta, San Joaquin River, as well as tributaries to each. From a statewide perspective, however, many anglers unable to fish at one venue are likely to travel to substitute locations. Accordingly, the adverse recreational economic impacts in one area, e.g. reduced fishing-related expenditures in Plumas County, are likely, at the state level, to be offset by increased expenditures at other fishing venues or for other types of recreation. These substitution effects are an important component of recreation demand discussed below.

The demand for recreation activities depends on many factors. Many books and articles are available on this topic, and a detailed review is not provided here. Generally, as reported by

Loomis and Walsh, some of the most important determinants of recreation demand at particular sites include (Loomis and Walsh 1997):

- Socioeconomic variables such as income, education, age, and ethnicity;

- Attractiveness or quality of the location;

- Availability of substitute or alternative recreation opportunities within a reasonable distance;

- Time to travel to the site;

- Crowding at the location; and

- Tastes and preferences, i.e. the type(s) of activities in which visitors want to participate.

The points of greatest interest for the statewide analysis are the availability of substitute or alternative recreation opportunities and the time required to travel to recreational venues.

Substitutability is a reflection of the extent to which one recreational experience can exchange for another (Kakoyannis and Stankey 2002). The demand for substitutes develops if the characteristics of one experience or venue become less desirable to recreationists. The availability of substitute or alternative recreation venues depends on the characteristics of a specific activity. For example, if anglers are somewhat indifferent between fishing at Lake Davis, Lake Almanor or Antelope Lake, reduced fishing opportunities at Lake Davis resulting from the pike should have minimal statewide impacts. However, if anglers particularly favor fishing for the trout stocked in Lake Davis specifically, then substitutability will be low and statewide economic impacts likely greater. Thus, if anglers who would normally visit Lake Davis choose to fish at other nearby locations or to pursue another form of recreation, such as hunting, the impacts at the state level are likely to be small. In either case, while businesses in different areas or in different industries may be affected, the overall impacts are likely to offset one another in the larger statewide economy (COE 2001).

If other nearby sites are less accessible or more crowded or otherwise less desirable to those who would normally fish and recreate at Lake Davis, there may be economic impacts beyond Plumas County. As reported in Section 11 of this report ("Recreation Resources"), several recreational sites are located within 100 miles of Portola and offer some of the same amenities as Lake Davis. However, it is also noted that some of these venues are less accessible, are generally more crowded, and have fewer facilities and less water surface than Lake Davis.

Travel time is also an important factor underlying recreation demand. In particular, both the time required to reach a location and the time available once there affect the demand for recreation at that site. For Lake Davis and the sites between Lake Davis and the Delta, the time to travel to alternative venues once the pike are established may be substantial. The greater the time to travel to a particular site, the lower the demand for recreation at that location (Loomis and Walsh 1997).

Data are not available on the physical impacts of pike escapement on desirable fish counts that are part of the various recreational fisheries between Lake Davis and the Delta and beyond. Therefore, it is difficult to estimate the extent that substitution of recreation sites

would occur. However, it is reasonable to assume that many anglers who would fish at Lake Davis would fish at nearby substitute sites. Similarly, it is reasonable to assume that many anglers who would normally fish the middle fork or main stem of the Feather River would also choose alternative sites. It is likely that reduced counts of salmon, striped bass, and other game fish in the Delta may also cause some anglers there to seek other venues for fishing. However, available data do not allow permit the calculation of these effects. As discussed in the Methodology section below, specific hypotheses are incorporated into a scenario in order to estimate the economic impacts of changes in the recreational fisheries potentially affected by pike escapement. The impacts should accordingly be viewed as being based on hypotheses rather than rigorously-defined assumptions.

I-2.3.3.3 Commercial Fishing Activities

The main source of commercial fishing impacts would be on anadromous salmon populations that use the Delta and upstream waters to spawn. Salmon, as well as other commercial species in the Delta, are attractive prey for the pike, but must be present in fresh or brackish waters for the pike to be considered a predator. Commercial fishing for salmon occurs mainly along the central and northern California coast. Consequently, the economic impacts on commercial fishing of pike escapement into the Delta may extend along these coastal area, but likely no further south than Monterey.

The substitution effects described above for recreation are less likely for other drivers of economic impacts, including commercial fishing or agriculture. In response to reduced fish counts or increased regulatory restrictions, the owners of commercial fishing boats may either necessarily scale back their operations in present locations or attempt to relocate to other nonimpacted areas, e.g. northern Oregon and Washington. The costs to do so are unknown, but could be substantial.

I-2.3.3.4 Delta Water Exports and Agriculture

The establishment of northern pike in the Delta may cause changes in the timing and quantity of water exports through the SWP and CVP systems. Such changes may be implemented for one or more of several reasons, including:

- Possible diminution of counts of Delta Smelt and other listed species;

- Desire to reduce entrainment of these or other species in Delta pumps; and

- Desire, based on annual growth cycle of northern pike, to reduce numbers of that species which may escape the Delta in the SWP and CVP canals.

If Delta exports are reduced beyond some unspecified threshold, two sets of impacts can be expected. The first is to agriculture, wherein reduced supplies to Delta export users would cause declines in crop yields or acreages or both, assuming alternative supplies are unavailable at reasonable cost. For some crops, such as grains and alfalfa, the statewide impacts may be quite small because farmers in other regions of the state may produce sufficient amounts to offset the reductions in the Delta export areas. For other crops, however, in particular specialized vegetables and fruits and nuts which may not be grown

easily elsewhere, there will be state-level losses if the water export reductions are sufficiently large and if alternative water supplies are not available. These impacts are expected to be concentrated in the San Joaquin Valley of California.

The second potential impact is to M&I supplies. Approximately 59 percent and 9 percent of SWP and CVP Delta exports, respectively, are for M&I contractors.[1] If Delta supplies to those contractors are reduced, the impacts could be large or small, depending on the availability of water from other sources and the costs of that water. If the supply reductions or costs are large, the statewide impacts could likewise be large. These effects would be concentrated in Southern California, where the largest M&I water contractors are located.

I-2.4   Methodology

I-2.4.1   Assumptions Regarding Potential Physical Effects of Pike Escapement

This analysis is necessarily both quantitative and qualitative. Data are available for some pertinent variables, such as the value of commercial fishing at various locations in California and the numbers of recreational anglers and their typical fishing-related expenditures. Data for other measures are either not available or are speculative. For example, the impact of pike escapement on physical counts of salmon or other species is unknown because of the many potential interactions and competition among many fish species between Lake Davis and the Delta. Similarly, it is not known to what extent pike escapement and establishment in the Delta would diminish the Delta Smelt population and over what period of time.

In addition, the impacts of pike escapement on potential Delta water exports currently are unknown. The California Resources Agency has prepared the "Delta Smelt Action Plan," which includes a discussion of the approach being used to estimate the effects of Delta water project operations on the species (California Resources Agency 2005). To date, the results from modeling are not available.

Because of these unknown parameters, this analysis uses hypothetical scenarios of potential reductions in recreational and commercial fishing and of Delta water exports in order to assess the potential statewide economic impacts of pike escapement. These scenarios are based on a hypothetical 10 percent reduction in the drivers of economic impacts. Using this approach, the results serve as an approximation of potential economic impacts that can be extrapolated to match real conditions if data become available.

The analysis for recreational fishing incorporates another assumption. As discussed previously, recreational anglers unable to fish at a particular location are in many cases likely to fish at other locations; or to substitute other activities for fishing. Accordingly, reduced recreational fishing in the Delta may be offset in part by increased fishing in northern California or elsewhere within the state. For this analysis, it is assumed for California residents that half (50 percent) of this decline is offset by anglers' fishing in other locations or participating in other recreational activities within the State. For the economic impact

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[1] Based on normalized average SWP and CVP deliveries during the period 1999–2003.

analysis, the reductions in angling days are translated into declines in expenditures in such recreation-related sectors as bait and tackle and sporting goods stores, restaurants, lodging, and boating stores.

The effects on Delta water exports due to establishment of the pike in the Delta are currently unknown. However, it is plausible that exports would be reduced for several reasons. First, the establishment of the pike would likely have an adverse effect on the number of Delta Smelt, Chinook salmon, and steelhead in the Delta, which is also affected by water exports. The cumulative impact on these fisheries would likely require that state and federal water system operators alter system operations such that more water remains in the Delta (and less water is exported) in an effort to help with fishery recovery strategies. Second, pike could become established south of the Delta via transport with Delta water exports, particularly if existing fish screens fail. In response to this risk, there may be pressure to curtail exports to minimize the risk of pike escapement into the SWP/CVP water delivery and storage infrastructure. Although pike establishment would be a unique situation, history provides some guidance on the variability associated with Delta exports over time. Between 1979 and 2004, annual exports of Central Valley Project water from the Delta pumping plants fell by as much as 39 percent and increased by as much as 130 percent. In the SWP system, annual water deliveries varied by as much as 45 percent (decrease) and 123 percent (increase).

As part of this analysis, potential reductions in Delta water exports were assessed by reviewing the history of Delta exports by the SWP and CVP together with the Combined Operating Agreement under which the two projects are cooperatively managed. However, due to the difficulties associated with forecasting changes in Delta water exports without data or other evidence taken from biological or related studies of the impacts of the northern pike, this study bases the economic analysis of water exports on a hypothetical 10 percent decline in annual water deliveries in the SWP/CVP systems south of the Delta, which is intended to demonstrate the importance between water deliveries and economic activity. To the extent that actual changes in water exports are higher or lower than this figure, the economic impacts would similarly be higher or lower.

I-2.4.2   Input-Output Model

The assumptions described above are necessary to estimate the direct economic impacts of pike escapement in the California economy; these direct economic effects are described in Section 6. The direct effects in turn generate indirect and induced economic effects, as measured by changes in economic output, income, and employment. To estimate the total economic effects of pike escapement, this study uses an input-output (I-O) model of the California economy (see Exhibit A). I-O models measure the extent of backward linkages[2] among sectors in an economy and allow the estimation of total economic impacts attributable to an assumed change in one or more other sectors. The I-O model used here is estimated with IMPLAN software and data.[3] IMPLAN is used regularly by economists and other

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[2] Forward linkages are not captured in standard I-O models. Most pertinent for this analysis is the fact that the I-O model does not capture forward linkages associated with commercial fishing and agricultural production (e.g., fish and other food processing), which can be substantial from an economic perspective.

[3] Minnesota IMPLAN Group, Stillwater, MN.

analysts to measure the local and regional economic effects of projects and policy changes. For the purposes of this analysis, a statewide (California) model was developed based on 2003 IMPLAN data, the most current dataset available at the time this report was prepared. Based on the large size of the California economy, no adjustments to the model were necessary.

I-2.4.3   Other Methodological Considerations

This study relies on secondary data sources to estimate economic impacts; no primary surveys were conducted or other data collected. References to these secondary data sources are found throughout the text.

The results of the impact analysis are presented on an annual basis. To the extent that impacts occur over multiple years, these impacts would continue. In addition, although the year of input values to the I-O model may vary, the results of the impact analysis are presented in constant 2005 dollars.

I-2.5   Hypothetical Scenarios of Potential Physical Effects and Management Actions in Response to Pike Escapement

This section utilizes the conceptual framework and methodology in combination with data availability and other issues to outline the key assumptions utilized to estimate the potential impacts of the northern pike throughout California. Much of the underlying data on fish counts, time for the pike to become established in the Delta, the rate of predation of pike on listed and other species, and other critical variables is unknown. Consequently, the assumptions developed reflect an inference on how key measurable variables such as numbers of recreational and commercial anglers and Delta water exports may be affected by pike escapement.

I-2.5.1   Physical Effects on Recreational Fisheries

If the pike were to escape from Lake Davis and become established downstream, it is reasonable to assume that many recreational fish species will be adversely affected. These may include the steelhead, salmon, trout, and others. Adverse physical effects on these fisheries, in turn, could have a substantial adverse effect on recreational fishing.

The potential effects on recreational fishing could extend throughout California; however, the immediate effects would likely occur in the Middle Fork of the Feather River, through Lake Oroville, and in the main stems of the Feather River and Sacramento River and the Delta. In addition, marine recreational harvests of Chinook salmon and other anadromous species could be limited due to declining fish populations as well as management actions by regulators to prevent extinction. Recreational fisheries throughout central and southern California, as well as other parts of the State, could be affected if pike were to be established south of the Delta through water exports or through illegal planting; however, these effects are not analyzed due to their speculative nature.

For purposes of this analysis, it is hypothesized that the pike establishment would result in a 10 percent reduction in recreational fishery populations and a 10 percent reduction in catch rates and number of recreational anglers. According to the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation in California (USFWS 2003a), approximately 2.4 million anglers fished in California in 2001, resulting in 27.7 million angling days. From a statewide perspective, most of these anglers are California residents (93.6 percent). Of this total, there were 1.9 million freshwater anglers and 19.4 million freshwater angling days and 932,000 saltwater anglers and 8.3 million saltwater angling days.[4] With respect to impacts on freshwater angling, it is assumed that pike establishment would mainly affect only those anglers in the region primarily affected by pike establishment (between Lake Davis and the Delta).[5] Based on fishing license data from DFG, the number of fishing licenses sold in this region accounts for 31.9 percent of all licenses sold statewide (DFG 2006b). Accordingly, it is assumed that 31.9 percent of freshwater anglers in the State would be affected by pike establishment. Based on these figures, roughly 595,000 anglers, generating 6.2 million angling days, could be affected. Of these totals, California residents account for 567,000 anglers and 6.0 million angling days. Based on the 10 percent assumption for recreational fishery impacts, pike establishment downstream from Lake Davis would result in an annual reduction of approximately 618,600 freshwater angling days, with about 599,600 days attributed to fishing by residents and 19,100 attributed to nonresidents of California. As summarized below, the related economic losses would be primarily due to reductions in the expenditures for various angler-related equipment and supplies and travel costs. These reductions in recreation-related spending patterns represent the direct impacts of pike establishment on freshwater angling-related economic conditions, are one of the inputs into the I-O model that is used to calculate the total statewide economic impacts of pike escapement.

Assumptions regarding the physical impacts on saltwater (marine) recreational fishing are outlined below. According to the 2005 California Recreational Fisheries Survey implemented by DFG, there were 2.4 million marine angler trips in California in 2005 (DFG 2006c). These trips are organized by geographic area (or district) and fishing mode.[6] It is assumed that recreational marine fishing would only be affected through central California, which includes the Central, San Francisco, Wine, and Redwood Districts. These four districts account about 849,000 (or 34.7 percent) of the total marine angling trips taken in California. However, not all of these trips are taken in pursuit of fish species potentially affected by pike escapement, as many recreational marine species are not anadromous and would not be affected by pike predation. It is assumed that the only species affected here would be Chinook salmon, and striped bass. These two accounted for about 24.2 percent of the total commercial passenger fishing vessel (CPFV) landings on the California coast (from Monterey north) in 2004 (DFG 2004). Based on these figures, there were approximately 205,700 marine angling trips taken

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[4] Numbers for freshwater and saltwater anglers do not necessarily add to total angling numbers due to multiple responses and non-responses (USFWS 2003a).

[5] This region is defined as Alameda, Butte, Colusa, Contra Costa, Marin, Napa, Nevada, Plumas, Sacramento, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Sierra, Solano, Sonoma, Sutter, Yolo, and Yuba counties.

[6] Four fishing modes were considered in the DFG report: man-made structures, beaches and banks, commercial passenger fishing vessels (CPFV), and private and rental boats.

in 2005 for the species and regions potentially affected by the northern pike. Most of these trips occur at beaches and banks (38.8 percent), followed by private and rental boats (34.4 percent), man-made structures (17.7 percent), and CPFVs (9.0 percent). Similar to freshwater fishing, the economic analysis is based on a 10 percent reduction in potentially-affected marine fishery populations and a 10 percent reduction in catch rates and angling trips. This translates into a total annual reduction of about 20,600 saltwater fishing trips. Based on data from the 2001 USFWS survey, and similar to freshwater fishing, most of these lost angling trips are attributed to California residents (97.3 percent), with only about 2.7 percent attributed to out-of-state visitors. Converted into angling days (from angling trips),[7] it is assumed that there would be a reduction of 24,200 resident- and 1,200 nonresident-marine angling days. In conjunction with marine angling spending profiles, these data serve as inputs into the I-O model to estimate direct and indirect economic impacts.

I-2.5.2   Physical Effects on Commercial Fishing

In 2004, there were 301.3 million pounds of commercial fish landings off the California coast, with a total value of $131.6 million (DFG 2005). In addition, commercial fishing landings in the Sacramento Delta totaled approximately 196,900 pounds and $233,800. It is assumed that impacts to commercial fish harvests would be limited to Chinook salmon, other salmon and salmon roe off the coast (from Monterey to the Oregon border), and to threadfin shad, pacific lamprey and crayfish in the Sacramento Delta. Based on these assumptions, a total of 6.3 million pounds of commercial fish landings could be potentially affected by pike escapement from Lake Davis. Due to uncertainties related to the potential physical impacts of pike on commercial fisheries, for purposes of this analysis, the analysis is based on a hypothetical 10 percent reduction in the annual commercial fish catch. This translates into a reduction of about 631,000 pounds of commercial fish landings.

I-2.5.3   Physical Effects on Delta Water Operations

The SWP and CVP provide export water through the Banks and Tracy Pumping Plants, respectively. The agencies have permits and licenses to appropriate water which are regulated by the SWRCB(USBR 2004b). The SWP and CVP coordinate the operations of the pumping plants with operation of the San Luis Reservoir. The use of San Luis Reservoir for a water supply requires storage of water there during the fall and winter, at which time the two pumping plants can export more water from the Delta than what is required for scheduled demands.

The shortage allocation policies of the SWP and CVP differ. Under the terms of the "Monterey Agreement," all SWP contractors, agricultural and M&I share equally on a pro rata basis in any allocation shortages (DWR 2006b). The CVP shortage policy calls for reductions in agricultural allocations of at least 25 percent before M&I supplies are reduced. The shortages among the two types of CVP users are determined according to the following schedule (including separate allocations for dry and critical years):

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[7]   It is estimated that the average number of days per saltwater angling trip is 1.21 (USFWS 2003a).

Table I-2-1. CVP Water Shortage Policy

Agricultural Allocation	M&I Allocation
NonDry and Critical Years	
75%-100%	100%
70%	95%
65%	90%
60%	85%
55%	80%
25-50%	75%
Dry and Critical Years	
20%	70%
15%	65%
10%	60%
5%	55%
0%	50%

Source: USBR 2004a

As explained above, it is not known to what extent the establishment of northern pike in the Delta would affect Delta exports. If the pike do become established and reduce counts of listed species, it is likely that DFG and FWS would use various measures to mitigate for those reductions, possibly including declines in Delta exports. There may also be pressure to limit water exports to curtail potential pike establishment in other parts of the State. The timing or duration of those cutbacks, however, is not known. In particular, many factors affect the CVP and SWP water allocations in any year, including:

- Forecasts of reservoir inflows and water supply conditions throughout the Central Valley;

- Amounts of storage available in upstream reservoirs and San Luis Reservoir;

- Projected water demands in the Sacramento Valley;

- Instream and Delta regulatory requirements;

- Annual management of water resources under provisions of the Central Valley Project Improvement Act; and

- Use of CVP and SWP export capacity through Joint Point of Diversion flexibility (USBR 2004b).

Thus, both the timing and duration of reductions in Delta exports due to pike escapement are unknown. Because of this uncertainty, this analysis is based on a hypothetical 10 percent annual reduction in both SWP and CVP exports, in accordance with the shortage policies described above.

SWP water exports to those water districts and agencies that rely on Delta exports are substantial. Based on a normalized average value of water supplies between 1999 and 2003,

it is estimated that approximately 2.94 million acre-feet of water is exported from the Delta to agricultural and M&I customers (DWR 2005). Of this total, roughly 1.7 million acre-feet (59.3 percent) is for M&I use and 1.2 million acre-feet (40.7 percent) is for agriculture. An assumed 10 percent reduction in SWP supplies would be incurred proportionally by M&I and agricultural interests based on applicable SWP shortage policies. This translates into a reduction of about 174,000 acre-feet and 119,600 acre-feet in M&I and agricultural water supplies, respectively.

CVP water exports are primarily for agricultural deliveries. Between 1999 and 2003, the average annual normalized value of CVP water exports from the Tracy and Banks pumping plants was approximately 2.6 million acre-feet. Of this total, about 2.2 million acre-feet (84.5 percent) was used for agriculture, 246,800 acre-feet was used for M&I, and 160,500 acre-feet was used for other purposes (mainly deliveries in federal and state refuges). An assumed 10 percent reduction in CVP water supplies would be borne entirely by agricultural interests based on the CVP shortage policy. Under these hypothetical considerations, therefore, approximately 262,300 acre-feet of CVP agricultural water supplies would be lost due to pike establishment in the Delta.

The following sections discuss the related physical effects on agricultural production and M&I activities from changes in Delta water exports.

I-2.5.4   Physical Effects on Agricultural Production

For the assumed reductions in Delta water exports, the impacts on agriculture depend directly on the cropping patterns on the land which will be affected. For SWP water, the primary agricultural contractors are Kern County Water Agency (in Kern County) and Tulare Lake Basin Water Storage District (in Kings County). The largest M&I users are in Southern California. For CVP water, agricultural users are concentrated near the Delta-Mendota Canal and San Luis Canal, in several counties.

The direct physical impacts of reduced Delta exports on agricultural production are estimated by converting reductions in available water (as outlined in Section 5.3) into reductions in agricultural acreage equivalents. This is done by assuming an average irrigation consumptive use of 2.5 acre-feet per acre of crops grown with SWP/CVP water.[8] Based on these assumptions and worse-case scenario of land fallowing in the absence of alternative water supplies, it is estimated that hypothetical reductions in SWP water supplies would result in a decrease of roughly 47,900 acres of agricultural production annually. An additional 104,900 acres of agricultural land would be fallowed based on reductions in CVP supplies.

I-2.5.5   Physical Effects on M&I Water Use and Economic Activity

The effects of reduced Delta water exports on the availability of M&I water and on economic activity depend on many factors such as the magnitude and duration of shortage, sources and

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[8] Consumptive use differs from application rate, which includes water beyond the consumptive needs of the crop irrigated and which reflects such factors as irrigation efficiency and leaching required to move salts out of the crop root zone. This figure is based on typical crops grown in the San Joaquin Valley (USBR 2004a).

costs of alternative supplies, intensity of industrial and commercial water use in different areas, and the potential for conservation. These impacts are not readily or easily measured, however, and are not quantified as part of this study.

Faced with shortages, each M&I supplier can mitigate for that shortage either with alternative supplies or by reducing usage. Many M&I agencies have more than one source of water, including groundwater and water transfers. Agencies with regular access to these sources may have considerable short-term and intermediate-term flexibility in meeting demands if Delta exports are reduced.

Residential users would be likely to adopt some of the techniques used during the 1987–1992 drought, e.g. reduce or eliminate landscape irrigation and replace vegetation at some later date, or install more efficient water-using fixtures and appliances. Businesses may be able to offset some of the higher costs or reduced supplies by implementing various conservation programs,[9] or shifting production to other locations. In more extreme cases, it may be necessary to curtail planned expansions or shut down (CUWA 1991).

I-2.6   Direct Economic Effects of Pike Escapement

The physical effects of pike escapement, as outlined above in Section 5, have the potential to generate substantial economic effects. This section quantifies many of the direct economic effects which could be attributed to pike escapement from Lake Davis. These direct physical effects, in turn, would generate indirect effects, which are quantified using a statewide I-O model in Section 7.

I-2.6.1   Changes in Recreational Fishing Spending

Changes in recreational fishing spending are based on estimated reductions in freshwater and saltwater angling and representative spending patterns by these distinct groups of anglers.

A hypothetical 10 percent reduction in the size of the recreational fisheries potentially affected by pike escapement was estimated to result in a decrease of 618,600 freshwater angling days. The loss of related spending into the California economy is calculated using the spending profile developed California State University, Chico (CSUC) for the estimation of local economic impacts attributed to the proposed Lake Davis Pike Eradication project (see Table I-2-2) (CSUC 2006). This profile is directly applicable to this analysis in that most of the recreation visitors come to Lake Davis to fish.

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9   Assuming that demand has not "hardened" so much that additional conservation is not possible. Possibilities include water recycling, wastewater treatment, changing production practices, and others (Association of California Water Agencies 1991).

Table I-2-2. Representative Freshwater Angler Expenditures per Day

Expenditure Category	$/Visitor Day
Restaurant Meals	$8.09
Lodging	$8.08
Transportation	$8.86
Fishing Related	$2.73
Groceries	$5.24
Other Local Retail	$2.60
Total Local Spending	**$35.60**

Source: CSUC 2006

Representative freshwater angling expenditure data used here indicate that approximately $35.60 per day is spent by anglers in the local economy. The largest sources of expenditures are transportation, restaurant meal, and lodging. The application of these spending data to estimate total changes freshwater recreational angling expenditures need to take into account resident versus nonresident spending patterns. As discussed in Section 3.3.2, it is assumed that losses of resident angler spending would not be completely lost to the California economy due to substitution effects. It is assumed here that 50 percent of resident spending lost due to reductions in angling would be spent in other recreation or leisure-related sectors of the economy. However, it is assumed that all nonresident angler spending would be lost because these visitors would likely opt not to travel to California to recreate. Based on these average values and assumptions, it is estimated that pike escapement would result in a total loss of $12.1 million in freshwater angling expenditures annually. Spending reductions are organized across industrial sectors based on the spending profile and then allocated to the corresponding sectors in the statewide I-O model.

A similar process was used to estimate changes in spending by marine anglers. It is estimated that a 10 percent reduction in potentially-affected marine fisheries would result in a decrease of 25,400 marine angling days annually, mainly by resident anglers. A separate spending profile was used to estimate change in marine angling spending – Marine Angler Expenditures in the Pacific Coast Region, 2000 (NOAA Fisheries 2001). Table I-2-3 shows representative spending data for the northern California region, organized fishing mode and resident status.

Table I-2-3. Representative Marine Angling Expenditures per Angling Day (2000 Values)

Expenditure Category	Mode	Resident	NonResident
Private Transportation	Party/Charter	$20.45	$72.00
	Private/Rental	$13.53	$64.24
	Shore	$18.50	$66.19
Food	Party/Charter	$16.49	$22.86
	Private/Rental	$8.96	$23.38
	Shore	$13.00	$29.27
Lodging	Party/Charter	$8.58	$45.04
	Private/Rental	$3.66	$10.21
	Shore	$9.90	$30.41
Public Transportation	Party/Charter	$1.83	$114.98
	Private/Rental	$0.13	$2.97
	Shore	$0.77	$36.92
Boat Fuel	Private/Rental	$9.71	$11.94
Party/Charter Fees	Party/Charter	$56.11	$51.62
Access/Boat Launching	Party/Charter	$0.84	$1.24
	Private/Rental	$1.22	$3.02
	Shore	$0.96	$0.15
Equipment Rental	Party/Charter	$5.13	$18.76
	Private/Rental	$0.67	$1.37
	Shore	$1.45	$4.62
Bait and Ice	Party/Charter	$2.60	$1.22
	Private/Rental	$6.03	$8.33
	Shore	$3.89	$6.24
Total	**Party/Charter**	**$112.03**	**$327.73**
	Private/Rental	**$43.90**	**$125.47**
	Shore	**$48.48**	**$173.80**

Source: NOAA 2001

In total, this profile indicates that resident anglers spend between $48.48 and $112.03 per angler day depending on fishing mode, while nonresident expenditures range between $173.80 and $327.73. Taking into account these values, estimated reductions in marine angling, and substitution effects (similar to the process outlined for freshwater angling expenditures), it is estimated that pike escapement would result in a total loss of almost $840,000 in marine angler expenditures annually. These values were allocated to the appropriate sectors in the I-O model.

I-2.6.2 Changes in Value of Commercial Fish Production

Information on value of commercial fishing landings is included in DFG's report of *Final California Commercial Landings for 2004*. Based on the hypothetical reduction of 10 percent

in commercial fish landings, it is estimated that about $1.75 million in salmon values and an additional $23,400 in commercial fisheries in the Delta would be lost due to pike escapement (2004 dollars). This equates to roughly $2.86 per pound of commercial salmon and $1.19 per pound of commercial harvests in the Delta. Changes in commercial fishing values are input into the I-O model to calculate this component of the total statewide economic impacts of pike escapement.

I-2.6.3   Changes in Agricultural Production Values

Changes in the value of agricultural production are tied to estimated reductions in agricultural acreage due to potential limitations in Delta water exports. The number of acres assumed to be fallowed is then multiplied by an average farmgate value (on a per-acre basis) for all crops grown in the service areas of the two projects.[10] Crop acreage and average crop farmgate value are based on data for Fresno, Tulare, Kings, and Kern Counties, the principal counties receiving Delta water for agricultural use. Information on crops grown in Fresno, Tulare, Kings, and Kern counties is shown in Table I-2-4. From 2000 through 2004, total harvested crops averaged 3,349,434 acres, and total production value (adjusted for inflation) averaged $7.288 billion. Average value per acre of harvested cropland was $2,176 (adjusted for inflation), excluding pasture, range, forest and wood products, and nursery products.

Table I-2-4. Agricultural Production and Values (2000–2004)[1,2,3]

Crop Type	Harvested Acres	Production Value	Average Value/Acre
Grains	676,682	$268,172,284	$396
Vegetables and Melons	367,490	$1,523,852,126	$4,147
Nuts	287,334	$716,083,697	$2,492
Fruits	739,332	$3,431,034,588	$4,641
All Other Crops	1,276,640	$1,261,147,606	$988
Total [4]	**3,349,434**	**$7,288,128,142**	**$2,176**

1.Data for Fresno, Tulare, Kings, and Kern counties

2. Excludes pasture, range, forest and wood products, and nursery products.

3. Represents normalized average annual values for the period 2000-2004; values in constant 2004 dollars

4. Total does not add up to sum of column due to normalizing procedures applied to each crop grouping.

Source: *California Agricultural Statistics Service 2001–2005*

While a 10 percent reduction in Delta exports is hypothesized for this assessment, it is unknown to what extent agricultural or M&I contractors of the two agencies would be able to replace Delta water. This analysis reflects the longer term, for which it is assumed that substitution is not possible. While substitution may occur in the short run, it would be at higher cost. Assuming consumptive use of 2.5 acre-feet per acre, the declines in SWP and CVP agricultural water exports would lead to the fallowing of approximately 152,800 acres. This loss of production is allocated proportionally across crop types based on existing cropping patterns. The average production value per acre is then multiplied by the amount of

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[10] Excluding range, pasture, wood and forest, and nursery products.

acreage fallowed for each crop type. In total, it is estimated that the hypothetical 10 percent reduction in Delta water exports due to pike escapement would result in a loss of $328.6 million (2004 dollars) in total agricultural production value on an annual basis. (It should be noted that to the extent that lower value crops are fallowed before higher valued crops, the estimated impacts are overstated.) This value was allocated across the appropriate agricultural sectors in the I-O model.

I-2.6.4   Changes in Municipal and Industrial Water Supplies

California has a large and rapidly-growing population as well as a large, diversified industrial base. These two sources of demand represent the main components of M&I water use. The population of the state is concentrated in Southern California and the San Francisco Bay Area, although population in the Central Valley is growing proportionately more than in either of the other two areas (State of California Department of Finance 2002, 2006). The Delta provides water for a large percentage of the population in the San Joaquin Valley, the San Francisco Bay Area, and Southern California through the SWP and CVP facilities.

The industrial base of the state is concentrated in the two key urban areas, although the Central Valley is also growing rapidly (USCB various dates). Water is a critical input for many industries in these areas, including food processing, electronics, petroleum production and refining, and chemicals.

Reliable water supplies are critical for M&I users, and disruptions can have severe impacts. During the 1987-1992 California drought, municipal water was rationed, prices were increased sharply to curtail usage, and nonessential water uses were limited or prohibited. Consumers installed water-saving plumbing fixtures, reduced landscape watering, and undertook other conservation measures to limit water use.

The drought prompted similar responses from industries, which implemented many programs to reduce both water costs and the risks of production losses (CUWA 1991). Businesses in many industries expended large sums to conserve water.

Water conservation by M&I users is a continual process. The *California Water Plan Update 2005* (DWR 2006a) notes, "Water conservation has become a way of life for Californians, most of whom have easy and affordable access to …water efficient plumbing fixtures, washing machines … at their local … stores, and nurseries." ""

For purposes of this analysis, it is assumed that exports of Delta water are reduced by 10 percent annually from average levels because of the establishment of northern pike in the Delta. CVP exports of M&I water would be unaffected in normal water years, but SWP exports would be reduced by 10 percent or roughly 174,000 acre-feet because of the respective shortage policies of the two projects.

The restrictions of M&I water would likely affect each SWP contractor differently, depending on alternative water sources (e.g. short-term and long-term water transfers and groundwater), the feasibility of continued use of those sources, and the potential for further conservation measures. It is likely that these variables would differ for each water provider. Generally, however, assuming water agencies purchase alternative water supplies at costs

higher than SWP water and pass those higher costs on to their customers, the economic impact would be comparable to a personal tax increase. Such a tax increase lowers disposable income and expenditures for a broad array of consumer goods.

The industrial impacts would also differ. Since the 1987-1992 drought, many industries have implemented various water-saving measures and, as a result, are less susceptible to temporary restrictions in water supplies. For the long term, however, it may be necessary for some businesses to supplement existing water sources with other supplies, likely at higher costs. If those costs were so high as to significantly reduce profitability of the businesses, some may choose to leave the area. Quantifying such predictions, however, is at best conceptual in the absence of specific data on how many businesses in each industry sector might be affected, the intensity of their water use, and many other factors.

The impacts of pike escapement on the availability of M&I water and then on urban economic activity are subject to many considerations. First, the agencies supplying water to residential, commercial, or industrial customers may have several sources of water and regularly choose that (or those) which provide the required water at the least cost. Sources may include groundwater, other surface water, and water transfers. In the short term (perhaps up to two years), the reductions in available M&I water may have little impact because of these various sources. Longer term, however, the alternative sources may not be economically justifiable. It is in these cases that reductions in industrial activity or increases in costs may be noticeable.

I-2.7   Regional Economic Effects

This section presents the results of the input-output modeling conducted for this study. The results show the representative changes in economic output, labor income, and employment attributed to hypothetical scenarios associated with pike escapement from Lake Davis. Economic impacts are organized into direct, indirect, induced, and total effects. They are also organized by the drivers of potential impacts: recreational fishing (freshwater and marine), commercial fishing and agricultural production, as well as total effects. All values are reported on an annual basis and monetary values are presented in constant 2005 dollars. These results are presented in Table I-2-5.

Table I-2-5. Direct and Regional Economic Effects[1,2]

Measure	Direct	Indirect	Induced	TOTAL[3]
Recreational Fishing (Freshwater)				
Output ($ million)	-$10.00	-$3.73	-$4.02	-$17.75
Income ($ million)	-$3.47	-$1.22	-$1.42	-$6.12
Employment (jobs)	-116.0	-24.4	-34.3	-174.7
Recreational Fishing (Marine)				
Output ($ million)	-$0.86	-$0.30	-$0.34	-$1.49
Income ($ million)	-$0.30	-$0.10	-$0.12	-$0.51
Employment (jobs)	-9.1	-1.9	-2.9	-13.9

Table I-2-5. Direct and Regional Economic Effects[1,2]

Measure	Direct	Indirect	Induced	TOTAL[3]
Commercial Fishing				
Output ($ million)	-$1.81	-$0.58	-$1.08	-$3.47
Income ($ million)	-$1.01	-$0.21	-$0.38	-$1.60
Employment (jobs)	-46.2	-3.7	-9.2	-59.2
Agricultural Production				
Output ($ million)	-$332.62	-$80.58	-$121.61	-$534.80
Income ($ million)	-$98.89	-$37.42	-$42.87	-$179.18
Employment (jobs)	-3,239.6	-1,168.7	-1,037.1	-5,445.4
Total [3]				
Output ($ million)	**-$345.28**	**-$85.19**	**-$127.05**	**-$557.52**
Income ($ million)	**-$103.67**	**-$38.95**	**-$44.79**	**-$187.41**
Employment (jobs)	**-3,410.9**	**-1198.8**	**-1,083.5**	**-5,693.2**

1. Values represent average annual changes in the statewide economy relative to existing conditions.

2. Monetary values reported in constant 2005 dollars.

3. Totals may not add to sum of rows and/or columns due to rounding.

Source: ENTRIX 2006 (based on IMPLAN modeling)

I-2.7.1   Recreational Fishing

Representative economic impacts from potential changes in recreational fishing were considered for both freshwater and saltwater (marine) fishing. The regional economic effects from a hypothetical change of 10 percent in freshwater fishing participation in the region potentially affected by pike escapement are presented below. The direct annual economic effects attributed to recreational freshwater fishing impacts include a decrease of $10.00 million in economic output, $3.47 million in labor income, and 116.0 jobs. In turn, these direct effects would generate additional economic effects resulting in a decrease of $17.75 million in total annual output, $6.12 million in total annual income, and 174.7 average annual jobs.

The regional economic impacts of potential reductions in saltwater fishing are less pronounced due to a relatively smaller angler base. A hypothetical 10 percent decline in saltwater fishing participation would result in a loss of $0.86 million in direct economic output, $0.30 million in direct labor income, and 9.1 direct jobs. Total economic effects include an annual loss of $1.49 million in total output, $0.51 million in total labor income, and 13.9 average annual jobs

I-2.7.2   Commercial Fishing

The regional economic effects from a hypothetical change of 10 percent in commercial fisheries potentially affected by pike escapement are presented below. The direct annual economic effects attributed to commercial fishing impacts include a reduction of

$1.81 million in economic output, $1.01 million in labor income, and 46.2 jobs. These direct effects would generate additional economic effects resulting in total decreases of $3.47 million in total annual output, $1.60 million in total annual income, and 59.2 average annual jobs.

I-2.7.3   Agricultural Production

Changes in agricultural production attributed to potential reductions in Delta water exports could be substantial. Based on a hypothetical 10 percent change in SWP and CVP water exports, statewide economic impacts from a reduction in agricultural production in the Central Valley would entail a loss of approximately $332.62 million in direct economic output, $98.89 million in direct income, and 3,240 direct jobs on an annual basis. The total economic effects of reduced agricultural production include losses of $534.80 million in total annual output, $179.18 million in total annual income, and 5,445 average annual jobs.

I-2.7.4   Total Regional Economic Effects

In summary, the direct economic losses associated with potential pike escapement scenarios total $345.3 million in annual output, $103.7 million in annual income, and 3,411 jobs. These impacts would be concentrated in the local economy where the impact occurs. From a statewide perspective, and based on the hypothetical scenarios described above, the total economic losses, on an annual basis, are estimated to be $557.5 million in total output, $187.4 million in total income, and 5,693 jobs. The largest declines would be in agricultural production because of reduced water supplies, assumed to be not replaceable.

The estimated total regional impacts would be substantial, based on the assumptions outlined above. However, the impacts would account for less than 0.01 percent of the total value of economic output in California ($2.48 trillion in 2003). The impacts on San Joaquin Valley agriculture would be comparatively much greater. The decline in agricultural output in Fresno, Kern, Kings, and Tulare Counties, the primary agricultural counties receiving SWP and CVP water, would be about 4.6 percent of the total farmgate value of $7.29 billion in those counties in 2004.

I-2.8   Costs of Anticipated Management Actions

In addition to the economic impacts presented above, it is likely that pike escapement from Lake Davis would induce an extensive array of management actions to minimize impacts and eradicate the pike. The costs of such actions are unknown and cannot be estimated in the absence of information on the location and extent of pike establishment. However, it is possible to gain some insight into potential management-related costs at the statewide level from the existing and projected costs associated with pike management at Lake Davis. According to DFG, current planning efforts associated with the pike eradication project at Lake Davis are estimated to cost over $6.63 million. An additional $5.0 million would be required for project implementation. It is plausible that comparable efforts at the statewide level would cost substantially more. The regional economic effects of potential expenditures by local government, including DFG, may not be substantial; however, these funds would

likely represent a shift from other government expenditures in other sectors in the State's economy.

I-2.9   Social Welfare Effects

For the purposes of this study, the analysis of social welfare effects focuses on the changes in net economic values attributed to recreational fishing; nonuse values, discussed below, associated with species existence are not evaluated here. As described above, freshwater and marine fishing could be impacted if pike are established downstream from Lake Davis. This analysis uses the same hypothetical 10 percent reduction in affected recreation fisheries and fishing opportunities as the basis for physical changes that could affect economic values attributed to recreation. From that point, a benefits-transfer approach is used to estimate changes in these values. The secondary source of data that is used in implementing the benefits-transfer methodology is the *Net Economic Values for Wildlife-Related Recreation in 2001: Addendum to the 2001 National Survey of Fishing, Hunting and Wildlife Associated Recreation* (2003).

I-2.9.1   Economic Values of Recreation - Background

Potential economic values attributed to recreation include both use values (i.e., values derived from actual use of a good or service) and nonuse values (i.e., values attributed to resources that are independent of the use of those resources). In the context of recreation, use values are attributed to actively participating in a particular activity, such as fishing, while recreational nonuse values mainly entail the knowledge that a particular recreation opportunity exists and could potentially be used in the future by current or future generations.

The economic use value of recreation could be interpreted in several ways. In its strict sense, it is defined as the expenditure (or monetary worth) that a person would be willing to pay to participate in a particular recreation activity. Building on this definition, "net economic values" refer to the expenditures that someone is willing to pay to recreate above what is actually paid, a concept referred to as "consumer surplus." Because recreational services typically are not directly traded in an open market, the values associated with these services are considered nonmarket values, which require nonmarket valuation estimation techniques. This study relies on secondary data sources that have estimated net economic values for fishing-related recreation in California.

I-2.9.2   Changes in Economic Values Attributed to Recreation

Based on the USFWS report referenced above, the average net economic value for trout fishing in California was $58 for state residents and $52 for out-of-state visitors. Adjusting these figures to 2005 values using the CPI yields net economic values of $64.67 and $57.98 for state and out-of-state anglers, respectively. For the purposes of this study, it is assumed that these values are representative of both freshwater and marine fishing opportunities that could be affected by pike escapement. Using these values and based on a hypothetical 10 percent in fishing opportunities, it is estimated that pike escapement could generate a loss of $41.51 million in net economic values related to recreational fishing, of

which $40.34 million is attributed to declines in resident angling and $1.17 million is attributed to nonresident angling.

I-2.10   Other Social Effects

I-2.10.1 Effects on Fishing-dependent Communities

Escapement of the northern pike from Lake Davis and establishment of the species in the Delta may adversely affect fishing-dependent communities and businesses throughout the northern part of the State. Because of its voracious nature, the pike may sharply reduce the numbers of other game fish from the middle fork of the Feather River through the Delta. While the impacts on such river-oriented communities as Oroville, Nicolaus, Verona, and Rio Vista cannot be estimated quantitatively with currently-available data, it is likely that anglers who prefer to fish for trout, salmon, and other species which are prey to the pike would fish less frequently in those locations. Communities with concentrations of recreation- and tourism-oriented businesses can be expected to be affected adversely as a consequence. In addition, coastal communities that are dependent on commercial fishing could be adversely affected if commercial salmon fishing opportunities are substantially curtailed.

I-2.11   Summary and Conclusions

The northern pike has established itself as one of the most threatening invasive species in California. Since the initial discovery of pike in the state in 1988, attempts have been made to eradicate the species, with limited long-run success. Since re-establishment in Lake Davis following an eradication program in 1997, the pike has been responsible for reduced catch rates for trout and other species in that location. A comprehensive eradication program is planned again for Lake Davis. The California Department of Fish and Game and U.S. Forest Service are preparing a joint Environmental Impact Report and Environmental Impact Statement relative to the eradication program.

This report is an assessment of the potential statewide impacts of pike escapement from Lake Davis and establishment of the species in the rivers and reservoirs from Lake Davis through the Delta. The primary types of impacts would likely be on recreational and commercial fishing, and on Delta water exports, which would generate potential impacts on both agricultural and M&I users of those water supplies.

The impacts on recreational fishing depend on the actions of individual anglers. If those anglers who would normally fish water bodies that are adversely affected by the pike choose to fish in other unaffected areas, the statewide economic impacts would likely be relatively small. (It is understood, however, that there could be serious local impacts in many different communities). If those substitution opportunities are not readily available, the statewide economic impacts would be larger. For commercial fishing, few substitutes are available, other than changing locations. If the pike adversely impact salmon, steelhead, or other species, it would be expected that fishing restrictions would be implemented, and commercial anglers may suffer impacts that cannot easily be mitigated.

For these reasons (i.e. adverse impacts on the listed Delta Smelt, striped bass, or salmon), as well as management actions designed to limit further expansion of the pike population, water exports from the Delta may be reduced should the pike become established there. Such actions may be taken both to limit the possibility of pike escaping south of the Delta and to reduce possible entrainment of listed species in the Delta pumps. Should exports be reduced, impacts to both agriculture and M&I water users could be expected. The extent of the impacts depends on such factors as the provider (whether SWP or CVP), the respective shortage policies of the two projects, and availability of alternative water sources.

The physical impacts of the likely responses to pike escapement and establishment downstream of Lake Davis are not known. Consequently, the statewide economic impact analysis is based on hypothetical scenarios related to potential physical impacts of pike escapement. These physical effects have been translated into direct economic effects, which were used as inputs into a statewide I-O model to estimate the indirect, induced, and total economic impacts pike escapement.

Overall, the potential economic impacts of pike escapement may be substantial. The largest source of potential economic impacts is attributed to reductions in agricultural production if available water supplies are curtailed. To a lesser extent, economic impacts related to reductions in freshwater and marine recreational fishing would occur.

I-2.12   References

Association of California Water Agencies. 1991. "California's Continuing Water Crisis, Lessons from Recurring Drought, 1991 Update." Sacramento.

California Agricultural Statistical Service. 2001–2005. "County Agricultural Commissioner's Data." Annual reports for the period 2000–2004.

California Bay Delta Program, Ecosystem Restoration Program. Date unknown. "Directed Action Proposal, Lake Davis Pike Eradication Project; Planning Feasibility Phase." Sacramento.

California Department of Fish and Game (DFG). 2004. "Commercial Passenger Fishing Vessel Fleet, Reported Catches for 2004."

DFG. 2005. "Final California Commercial Landings for 2004." Sacramento.

DFG. 2006a. "Lake Davis Administrative Memorandum." February 11, 2006, supplemented March 2. Sacramento.

DFG. 2006b. Sport Fishing Licenses Purchases by Residents, by County. Available online at: http://www.dfg.ca.gov/licensing/statistics/statistics.html#Sport%20Fishing%20Licenses.

DFG. 2006c. "California Recreational Fisheries Survey 2005 Annual Review." Prepared by the Department of Fish and Game-Marine Region. March 2006.

California Department of Water Resources (DWR). 2005. "Management of the California State Water Project, Bulletin 132-04," Sacramento. September.

DWR. 2006a. *California Water Plan Update 2005*. Sacramento.

DWR. 2006b. "Joint Statement on the Monterey Amendment Litigation," Internet website http://www.montereyamendments.water.ca.gov/ accessed April 26, 2006.

California Resources Agency. 2005. "Delta Smelt Action Plan," Sacramento. October.

California State University, Chico (CSUC). 2006. "The Economic Impact on Plumas County of Alternative Northern Pike Eradication and Management Scenarios for Lake Davis: A Preliminary Report." Prepared by the Center for Economic Development. California State University, Chico. March 20.

California Urban Water Agencies (CUWA). 1991. "Cost of Industrial Water Shortages," prepared by Spectrum Economics, San Francisco. November.

Ciruna, K.A., L.A. Meyerson, and A. Gutierrez. 2004. "The Ecological and Socio-Economic Impacts of Invasive Alien Species on Inland Water Ecosystems," report to the Convention on Biological Diversity on behalf of the Global Invasive Species Programme. Washington, District of Columbia.

Kakoyannis, Christina, and George H. Stankey. 2002. "Assessing and Evaluating Recreational Uses of Water Resources: Implications for an Integrated Management Framework." U.S. Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-536. Portland, Oregon.

Layman, R. Craig, John R. Boyce, and Keith R. Criddle. 1996. "Economic Valuation of the Chinook Salmon Sport Fishery of the Gulkana River, Alaska, under Current and Alternate Management Plans." *Land Economics.* Volume 72, Number 1, pp. 113–128. February.

Lee, Dennis P., California Department of Fish and Game. 2001. "Northern Pike Control at Lake Davis, California." *American Fisheries Society*, pp. 55–61.

Loomis, John B., and Richard G. Walsh. 1997. *Recreation Economic Decisions: Comparing Benefits and Costs*, Second Edition. Venture Publishing. State College, Pennsylvania.

Lovell, Sabrina J., and Susan F. Stone, National Center for Environmental Economics. 2005. "The Economic Impacts of Aquatic Invasive Species: A Review of the Literature." Working Paper # 05-02, Environmental Protection Agency, Washington.

NOAA Fisheries. 2001. "Marine Angler Expenditures in the Pacific Coast Region, 2000." Prepared by Brad Gentner, Michael Price, and Scott Steinback. NOAA Technical Memorandum NMFS-F/SPO-49. October.

Perrings, C., M. Williamson, and S. Dalmazzone (editors). 2000. *The Economics of Biological Invasions.* Cheltenham, Edward Elgar, cited in Lovell and Stone, op.cit.

Pimentel, David. 2003. "Economic and Ecological Costs Associated with Aquatic Invasive Species," *Proceedings of the Aquatic Invaders of the Delaware Estuary Symposium*. Penn State Great Valley Campus, Malvern, Pennsylvania.

Pimentel, David, Rodolfo Zuniga, and Doug Morrison. 2004. "Update on the environmental and economic costs associated with alien-invasive species in the United States." *Ecological Economics*, Volume 20.

State of California, Department of Finance. 2002. "Revised Historical City, County and State Population Estimates, 1991-2000, with 1990 and 2000 Census Counts." Sacramento. March.

State of California, Department of Finance. 2006. "County Population Estimates and Components of Change by County, July 1, 2000–2005." Sacramento. March.

U.S. Army Corps of Engineers (COE). 2001. "Assessment and Evaluation of the Drawdown Regional Economic Workgroup (DREW) Recreation Analysis Findings." Prepared by Foster Wheeler Environmental Corporation and Dr. Charles C. Harris, University of Idaho. Walla Walla District.

U.S. Bureau of Reclamation (USBR). 2004a. "Water Transfer Program for the San Joaquin River Exchange Contractors Water Authority, 2005 to 2014, EIS/EIR." Prepared by URS Corporation. Sacramento, California.

USBR. 2004b. "Long-Term Central Valley Project Operations Criteria and Plan CVP-OCAP." Sacramento, California. June 30. p. 2-2.

USBR. 2005. "Municipal and Industrial Water Shortage Policy, Central Valley Project, California, Environmental Assessment." Sacramento, California. October.

U.S. Census Bureau (USCB). Various dates. "County Business Patterns." Washington, District of Columbia.

U.S. Department of Interior and U.S. Department of Commerce. 2003. "2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, California." FHW/01-CA-Rev. Washington, District of Columbia.

U.S. Fish and Wildlife Service (USFWS). 2003a. "2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Revised 2003."

USFWS. 2003b. "Net Economic Values for Wildlife-Related Recreation in 2001: Addendum to the 2001 National Survey of Fishing, Hunting and Wildlife Associated Recreation."

EXHIBIT A
THE USE OF INPUT-OUTPUT ANALYSIS

IMPLAN is a system of software and databases used to construct regional economic models. It is based on I-O methodology, which quantitatively measures the interdependence among economic sectors. Each sector not only produces goods and services, but also purchases goods and services for use in the production process. Quesnay originally conceptualized these relationships in 1758. Leontief published an I-O system of the United States economy in 1936.

The IMPLAN approach is based on I-O methodology that has been modified for regional data retrieval, model development, and impact analyses. It can be used to analyze the distinct regional characteristics or impacts associated with broad-level policy changes or economic problems. IMPLAN is a "nonsurvey" I-O system, as it does not require primary, survey-based data. IMPLAN is an important tool to analyze regional impacts of policy changes because of the ease with which specific regional or local information can be incorporated into a model.

IMPLAN was developed for the US Forest Service by the University of Minnesota to assist in land and resource management planning issues. It has been used since 1979, initially as a mainframe-based, batch-mode program. It was converted to an interactive, menu-based microcomputer program in 1989 and has been refined continually since then.

REGIONAL ANALYSIS

Regional analysis is a form of economic analysis that recognizes the distinctness of a geographical area in terms of its resources, industries, and relationships with other areas. In general, smaller regional economies are more dependent on trade with other regions for "imports" and "exports" of goods and services than are larger regions. Regional growth is enhanced by the outputs of its export industries. In this study, agriculture and sectors related to agriculture export many of their products outside the region and are consequently important contributors to growth in the area.

Regional I-O analysis is based directly on the Leontief framework developed for the national economy. Regional I-O models are extensions of that basic structure that reflect regional differences in production processes. As an application tool, IMPLAN is able to capture these relationships in straightforward fashion. The matrix algebra is cumbersome, though relatively quick with high-speed microcomputers, and is not repeated here.

ESTIMATION PROCESS

The steps in the development and use of an IMPLAN model are relatively straightforward because of the software itself. However, logic and interpretation are required at each stage to minimize the potential for inaccuracies and to maximize the usefulness of the model.

Define Problem

IMPLAN can be used to analyze such diverse issues as the impacts of changes in regional agriculture, the closure of military bases, entrance of new industries into an area, construction of recreational facilities, and changes in national or local government policies. The specific problem must be defined in terms of the resources it will affect, in which industries, and in which locations.

Define Study Area

IMPLAN is a county-based application, and a study area can include one or more counties or entire states. The study area defined for a problem is important because the impacts related to the problem depend directly on the size of the area and linkages among the industries. The study area should center on the location of activities for which impacts are to be measured. The area should include the locations of principal buyers and sellers of the goods and services central to the analysis. If household purchases of the goods and services are important, the study area should also include the locations of consumers. The area should be sufficiently large to include the industries and consumers which will be affected by the events being analyzed, but not so large as to lose resolution of the most-impacted sectors.

The study area may include the locations of key backward and forward-linked industries to the sectors of interest. Backward linkages are those between an industry and its suppliers, e.g., between vegetable growers and farm chemical dealers. Forward linkages are those between an industry and other industries which use or add value to the product, e.g., between rice growers and rice mills. I-O models capture backward linkages only. For that reason, regional models should account for any important forward linkages within the study area. For this analysis, the regional study area of interest was defined as Plumas County.

Compile and Edit Regional Data and I-O Accounts

The IMPLAN database includes 21 economic and demographic variables for more than 500 sectors for all counties in the United States. The analysis in this study utilizes the 2003 IMPLAN database, which was the most current at the time the study was begun. The data are taken from numerous state and federal sources such as the National I-O accounts, the National Income and Product Accounts, Census data, and a host of other published sources.

Derive Multipliers

A multiplier measures the difference between an initial change and the final effects of that change. Multipliers can express the direct or combined direct and indirect effects of a change. Direct effects are those that occur in regional industries from which a particular sector purchases and are sometimes called first-round changes. Indirect effects incorporate two measures: (1) the regional production necessary to support changes in a given industry's direct requirements; and (2) the regional production that is stimulated by consumer demand caused by payments for labor by a given industry. The second of these is sometimes referred to as induced effects.

Analyze Impacts

Impact analysis involves the measurement of direct, indirect, and induced output, employment, and income effects of changes in final demand in sectors of the regional economy. Impacts are calculated using estimated multipliers and the changes in final demand.